MECHANICAL ENGINEERING

· MAY 1949 ·

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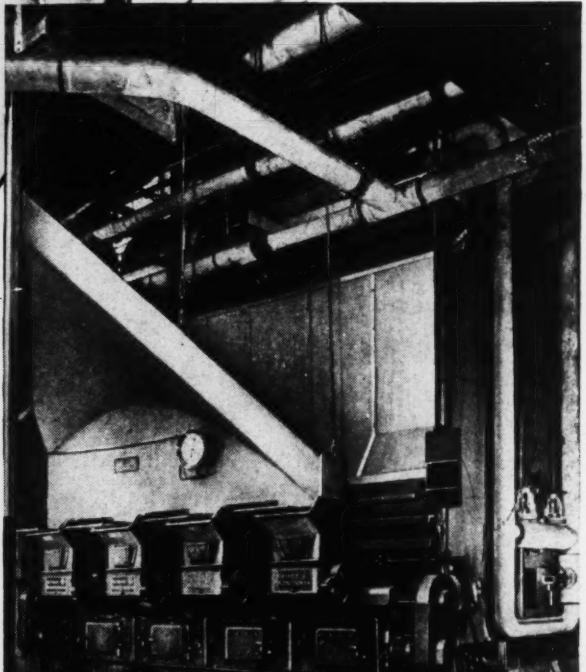
Makers of *Community* "stir up" new economies with boiler modernization



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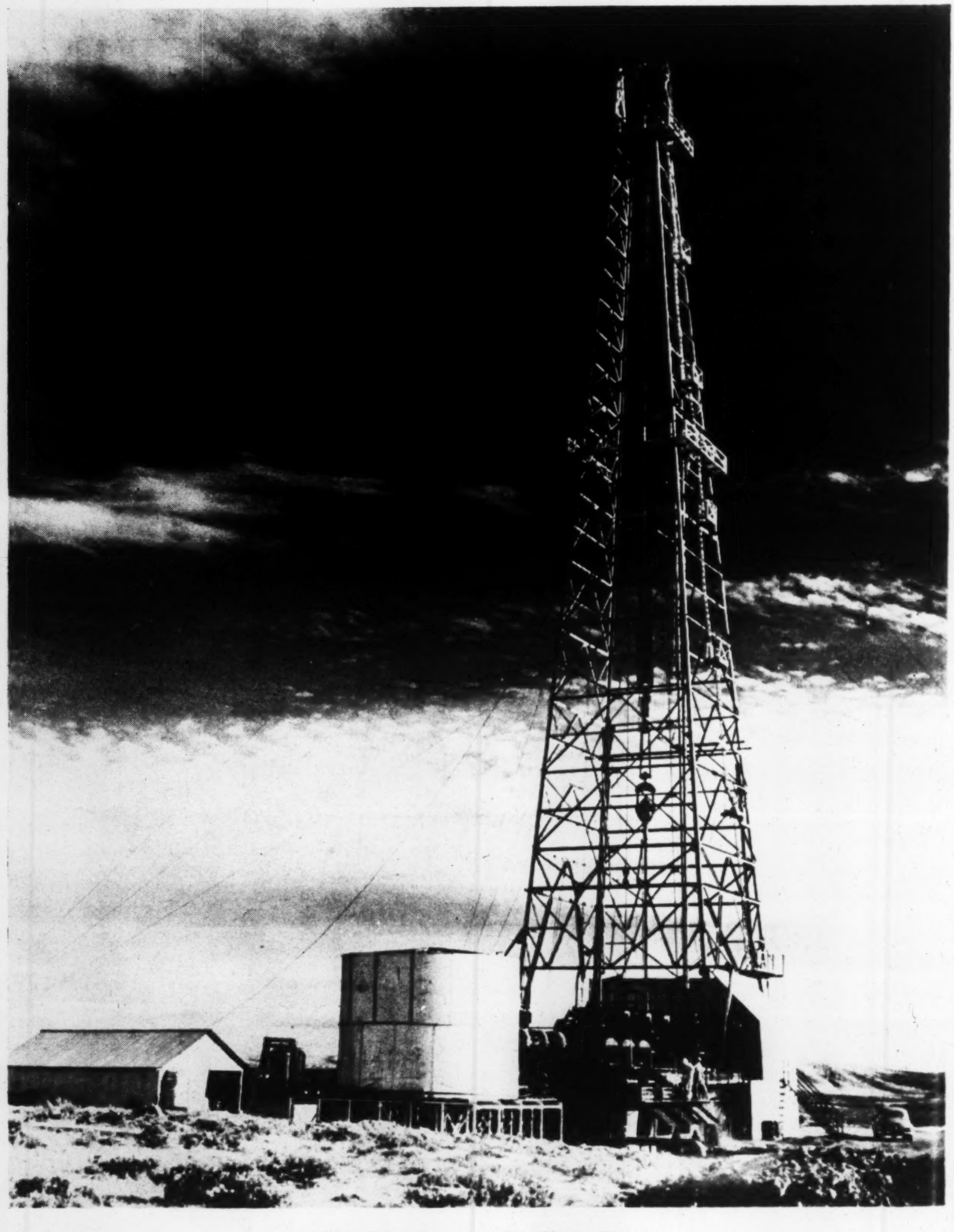

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MECHANICAL ENGINEERING

MAY
1949

GEORGE A. STETSON, *Editor*

UNESCO at Cleveland

IN the hundreds of American citizens who assembled in Cleveland, Ohio, for the Second National Conference of the United States National Commission for UNESCO (United Nations Educational, Scientific, and Cultural Organization), March 31–April 2, 1949, the spokesman of the engineers was Robert M. Gates, of New York, representative of the Engineers Joint Council on the U. S. National Commission.

For the benefit of readers whose memories may need to be refreshed it should be recalled that within the structure of the United Nations there exists an Economic and Social Council charged with carrying out under the General Assembly the functions of the United Nations in seeking to promote economic, social, cultural, educational, health, and related conditions. The Council has numerous commissions and committees and eight agencies, of which the United Nations Educational, Scientific, and Cultural Organization (UNESCO) is one. The Secretariat of UNESCO is in Paris, and the Director General is Dr. Jaime Torres Bodet, former Foreign Minister and Minister of Education of Mexico. UNESCO's mission is to promote international intellectual co-operation through the free exchange of ideas on education, art, and science.

The constitution of UNESCO was signed in London on Nov. 16, 1945, and on July 30, 1946, President Truman signed Public Law 565 which authorized membership of the United States in the new organization and established the United States National Commission for UNESCO as an active agent of our membership. The National Commission consists of 98 members—60 representatives of national organizations (of which Engineers Joint Council is one), 14 members at large, 15 representatives from state and local governments, and 9 Federal Government representatives. Milton S. Eisenhower is chairman of the Commission; the vice-chairmen are Detlev Bronk, Waldo G. Leland, and Justin Miller; the executive secretary is Charles A. Thomson, of the Department of State; and the executive committee is made up of 12 members of the Commission.

The purpose of the Conference was "to give information on UNESCO's program and on the work being done by organizations, institutions, and committees of the United States in furthering UNESCO's objectives; and to stimulate further activity in the United States during the next two years on UNESCO's objectives." The program was divided into plenary sessions, at which formal addresses by distinguished persons were featured; section meetings, at which panels of experts discussed six areas within which community groups find opportunity to work on UNESCO's objectives; and numerous group meetings where the intent was "to show how American community channels—the organizations, institutions, and mass media through which ideas are conveyed to people—may be used to create understanding of the problems of the six section meetings."

EJC and UNESCO

IT was at the group meeting on Professional and Scientific Organizations that R. M. Gates, member of the United States National Commission, spoke on behalf of the Engineers Joint Council, whose representative on the Commission he is. Mr. Gates convinced a mixed audience of about 100 persons, whose interests lay in natural and social science, education, the humanities, medicine, and engineering, each with his own special field of interest, his own vocabulary, his own sense of the significance of his profession in the modern world, and his own degree of enthusiasm for the task of international co-operation, that engineers have many practical achievements to their credit in international affairs, that their interest has been of long standing, and that they are animated by the spirit of UNESCO.

Speaking on the subject, "The Relation of the Engineering Profession to UNESCO Objectives," Mr. Gates said that the development of resources to meet material needs was primarily an engineering job. Engineers are aware of the fact that a better understanding of the culture and customs of a people is essential if technological assistance to them is to be fully effective, he asserted; and it was his belief that technical knowledge and assistance should be on UNESCO's program.

Mr. Gates described the organization of the Engineers Joint Council with its five principal and 50 related engineering groups, representing at least 100,000 engineers, 10,000 of whom lived outside the United States, and referred to other engineering societies in Canada, Great Britain, Western Europe, and Latin America. He told his audience about participation in the World Engineering Conferences at Paris, Zurich, and Cairo; about the conference of engineering-society representatives held in London last October and EJC's instructions to its delegates; about the Pan-American Union of Engineers to be organized at Rio de Janeiro in July of this year, for which EJC will provide about 80 papers; and about a request received from engineers of Latin America that the Engineers' Council for Professional Development aid them in setting up a procedure for accrediting the engineering curricula in their colleges. Mr. Gates said that American engineers believed that any world engineering organization to be set up should permit its member societies to preserve all their independent rights, but at the same time improve direct exchanges and relationships among them.

As examples of how engineers are using pooled resources he recited several EJC projects. The Overseas Consultants, he said, was organized in 1946 by a number of well-known engineering firms at the suggestion of the Department of State to make certain studies with regard to reparations policies. This group was later reorganized to study social and economic conditions in other countries. It undertakes no engineering construction, he said, but suggests ways of financing and plans of performing construction. Other examples were cited.

Mr. Gates said that he had mentioned national and international organizations and their work to indicate that engineering societies had been conscious of their international obligations, and "to emphasize the resources of trained and experienced engineers and engineering organizations available for furthering the main broad purpose with which UNESCO is concerned. . . . . The whole problem of world peace and prosperity requires for its solution the constantly increasing use of engineering."

It was on the realistic, yet idealistic, note of the orientation needed "not only by engineers but by all others who enter into UNESCO's world-wide task" that Mr. Gates concluded his remarks in the following words:

"We have to try to help many peoples to build structures for better living. They need and wish the help that our people are best able to give. They know something about our material resources, our use of novel techniques, and our success in combining them for advance of living standards. At the same time there is a fear of rude disruption of their traditional way of life. True, we have not always chosen our political, religious, industrial, or other representatives to foreign countries for their understanding or adaptability. If America has been successfully pictured to other peoples as a land of plenty, our way of life has not always seemed to them ideal in other respects. They would like a scale of living nearer the American standard, adjusted to their customs and their ancient culture.

"This better structure of living must be built on their own foundation. If the pattern is to be changed, to permit a structure that fits their own aspirations, we must let them change it as they come to see the need themselves. They want opportunity to climb to a higher plane of living, but that may be quite different from the North American or Western European way of life.

"We can understand their needs and their wants only if we identify ourselves with them closely enough. Any attempt from outside to erect or to superimpose an economic social structure of alien character—without regard to what is in their minds and hearts—is bound to fail.

"Business enterprises are taking and should take an important part in raising standards of living the world around. This not only promotes world trade but serves the cause of world peace. They can operate in foreign countries only under such arrangements as may be found mutually satisfactory. Wherever they adapt their operations to the local human situations and exercise the human responsibilities that their privileges impose, they perform a service in line with UNESCO objectives. We should seek and expect their co-operation in so far as their aid may fit into the purposes of UNESCO and not create misunderstanding of its altruistic aims.

"Finally, I need hardly add that all who take part in the curative and creative work promoted by UNESCO need not only this human understanding, but also a spirit of unselfish service. There is a great need for people to be trained in our colleges and universities for such work. As personnel is selected for foreign work, we should insist upon capacity for unselfish devotion to a cause, as well as capacity for intelligent insight into and judgment of the realities involved. Such unselfishness, insight, and judgment should also pervade all our planning. Thus we shall humanize our efforts to help others, making their efforts truly effective—and, incidentally, we shall humanize our attitudes toward the problems of our American society."

What is the spirit of UNESCO? In the speeches at Cleveland one heard many phrases in which attempts were made to express it: Intellectual and moral solidarity of mankind; world community of mind; a symbol of peace; ideals of justice toward all; a struggle to build up and never to destroy; human rights; doing things together; studies of tensions; release of creative energies; channels of communication between peoples; peoples' agency for peace; peoples talking with peoples; world peace through world understanding. What have these phrases to do with engineering? Perhaps Mr. Gates gave the best answer to this question in the opening paragraph of his remarks: "Engineering," he said, "has to do all the time with people. It can accomplish nothing without the co-operation of people. Its achievements are futile if they do not benefit people." The spirit of UNESCO is people.

When Mr. Gates concluded, he was followed by Dr. Louis Wirth, sociologist and educator, who said that he and Mr. Gates were working in the same field. Here, perhaps, is the crux of the matter. The engineer and industrialist, speaking in his vernacular from his own background of experience, and the sociologist and educator, using the vocabulary of his profession and interpreting the results of his own studies, found a common denominator in people. If UNESCO has significance, it is to be found in the fact that it starts with people and is interested in people and their welfare as people. Cynics may think of the earnest and eager folk who flock to UNESCO meetings as "do-gooders," dreamy visionaries, with a zeal for minding the affairs of others and for spending other people's money, long on talk and short on accomplishment. If one will penetrate the confused and effervescent fringe which surrounds the sound core of UNESCO, from which results are already beginning to flow, he will find the spirit of UNESCO to be the same as the spirit of engineering—simple service to the people.

ELECTRICAL CONTROLS *in* THREAD-GRINDER *Design*

Controlling Automatic Functions of Thread Grinders Electrically

By E. V. FLANDERS

CHIEF ENGINEER, THREAD GRINDER DIVISION, JONES & LAMSON MACHINE COMPANY, SPRINGFIELD, VT.

FOR purposes of discussion, electrical controls are to be considered as newer devices available to the machine designer to use with or in place of well-known mechanical and hydraulic movements. The electrical engineer's viewpoint will be avoided. It is not necessary that the machine designer be versed in the subject of circuits, sizes of devices, and the like. Such matters can be entrusted to a capable electrical engineer, who, working closely with the designer, can assure that the requirements of various electrical codes, such as the Machine Tool Industrial Control Standards, are met. It is the duty of the electrical engineer to work out and simplify circuits, keep abreast of the latest designs in electrical devices, and to maintain accurate records of wiring diagrams for future reference. It is also the duty of the electrical engineer to render such electrical service as may be required by the customers.

REASON FOR RECENT ADVANCES IN USE OF ELECTRICAL CONTROLS

In recent months it has become evident that electrical controls are finding wider use on machine-tool applications. This development has been most noticeable on automatic or semiautomatic machines. There are many reasons for this. Among them may be mentioned the following:

1 In many cases it has been found simpler to perform a function electrically than mechanically.

2 Electrical controls enable a designer to adapt new equipment, which previously had not been contemplated, to a standard machine, thus meeting the needs of the customer who wants additional tooling or equipment to suit some special need; and this without major machine-design changes.

3 Electrical controls are very flexible. Changes in sequence which might be difficult or expensive to make hydraulically or mechanically usually can be made quickly and easily electrically. When changes are needed in established design either to improve the performance of the equipment or to satisfy some new demand of the customer is a case in point.

Many electrical devices are available to the mechanical engineer. Actually he needs to know well the uses of only a few of the conventional devices. Those we find most useful are as follows:

1 Limit switches, which are operated mechanically, initiate a function during machine cycle by opening or closing pilot control circuits.

2 Selector switches determine what sequence of operations will be followed and at times may make parts of the control system inoperative.

3 Timers are used to slow down one sequence of operations in relation to another, allowing one function to take place ahead of the other.

4 Counters are useful wherever a predetermined number of operations must take place before another series of operations can be performed.

5 Solenoids are used for straight-line motions of limited stroke and power.

6 We are all familiar with push buttons and their application to across-the-line starters. Frequently it is found practical to use push-button controls for some manual operations, such as work jogging, or to operate electrically controlled hydraulic or pneumatic equipment performing some function, such as work clamping or opening and closing of guards.

Many other devices are available, such as float switches, pressure switches, magnetic clutches, magnetic brakes, indicating meters, indicating lights, and so forth. All of these must be considered when planning any new electromechanical movement.

It will be found necessary to use many other devices with those listed, such as relays, contactors, condensers, resistors, etc. However, other than preparing the sequence of operations, it is not the function of the mechanical engineer to develop the ultimate electrical layout. This is entrusted to the electrical engineer who will select suitable control apparatus and combine the units to obtain the desired results.

Then estimates of the cost can be determined. The decision can be made at that time whether to do the job electrically or whether perhaps a mechanical or hydraulic solution might be best.

TYPICAL EXAMPLES OF ELECTRICAL CONTROL

Fig. 1 is an example of a function performed simpler and better electrically than it was mechanically. On early thread grinders produced by the author's company, a mechanical spring-loaded trip had been designed to be actuated by the work-travel dogs. This trip released the reversing mechanism which moved the work slide back and forth by the grinding wheel. A considerable amount of pressure was required to operate this mechanism. When using a grinding stroke which had considerable overtravel at each end of the thread, no difficulty was encountered. However, in cases where a thread was short or where it was necessary to work very close to a shoulder, it was discovered that there was lead error in the ground thread which was not present in the master lead screw. Careful study indicated that the resistance set up in the reversing mechanism actually was slowing down the work slide, owing to strain on the driving parts. As a result, a lead error of several tenths of a thousandth was present in the ground thread. This was a case where the machine was already in the customer's plant.

The lead error was beyond the required specifications, and a correction had to be made immediately. We substituted a limit switch for the lever arm which had connected the trip

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Contributed by the Machine Design Division and presented at the Spring Meeting, New London, Conn., May 2–4, 1949, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

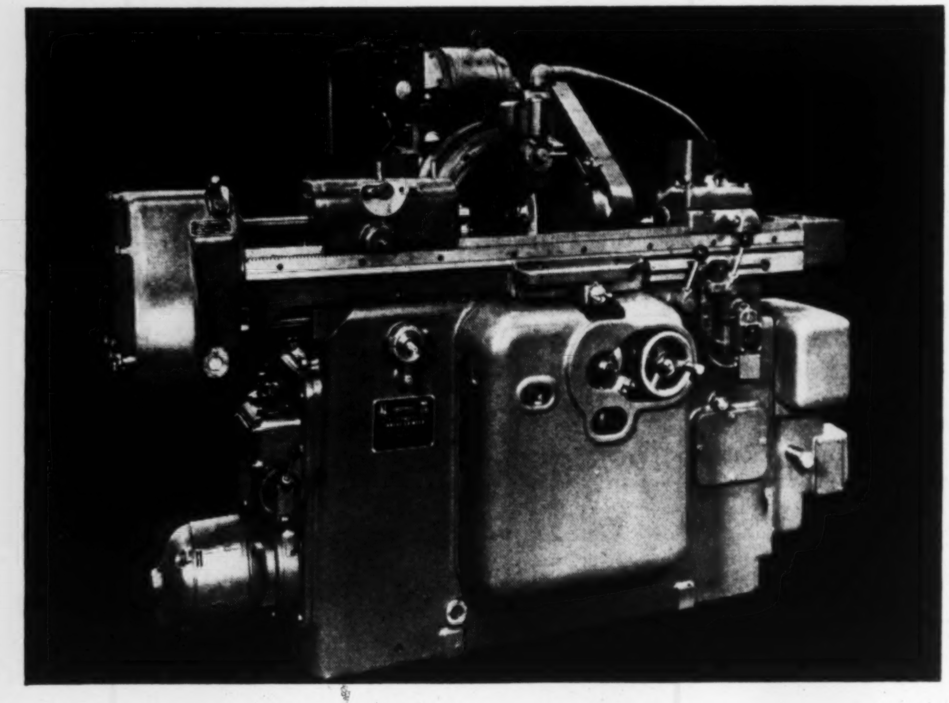

FIG. 1 6 × 36 AUTOMATIC THREAD GRINDER

dogs with the reversing mechanism. The limit switch actuated a solenoid which performed the function previously performed by mechanical means. It took practically no pressure to operate this limit switch. If we had tried to lighten the spring load so that it was no longer a factor in producing lead error, it would have meant a complete redesign of the reversing mechanism which otherwise was performing satisfactorily.

This method of reversing the direction of slide travel has been made standard on all of our thread-grinding machines ever since. In Fig. 2, *A* is the reversing lever; *B* the adjustable-stroke dogs; *C* is the snap-action limit switch used to control the reversal; *D* is an overtravel limit switch which is used in the event of the failure of the main limit switch.

Another example of the ease and convenience of electrical controls is shown in Fig. 3. Here we see a rear view of the machine with the truing device mounted in place behind the grinding wheel. The truing device is a self-contained unit with its own drive motor. Besides the electrical connections to the drive motor, there are limit switches in the device which perform other functions to be described later. These functions are common to all truing devices. Because of the wide complexity of forms required, many types of truing devices are needed to cover all requirements. It will be noted that the truing device is connected to the bed by means of a simple four-circuit plug and receptacle. To change from one type of truing device to another is no more difficult electrically than switching from a toaster to a flat iron in the average kitchen. The devices are so designed that they may be changed from one machine to another where they will operate automatically, provided the voltage and frequency specifications are the same. It can be seen readily that the problem of moving from one machine to another would be much more complicated if the drive between machine and device were mechanical.

Fig. 4 shows the dog plate on the cam-drum assembly. This plate and the two limit switches enable the operator to select six different types of grinding cycle on any standard machine by changing the location of the dogs. This gives some indication of the versatility of electrical controls on an automatic cycle.

FUNCTIONS OF MANUALLY OPERATED CONTROL-CIRCUIT ELEMENTS

There are two distinct functions for manually operated elements in any control circuit. Certain elements are used only in setup, others may be operated either to start the machine in operation or to make occasional adjustments or changes in the machine during operation. We have separated these elements according to their function. For normal machine operation it is our practice to have within easy reach of the operator what we call an operator's panel. Fig. 5 shows this panel. It has the necessary push buttons and selector switches to keep the machine in operation for any given setup. They are the various devices which the operator will have to manipulate in starting and stopping his machine or in making certain adjustments, such as dressing-in a new wheel, or in changing diamonds. It is considered the best practice for the operator to have only a minimum number of elements within

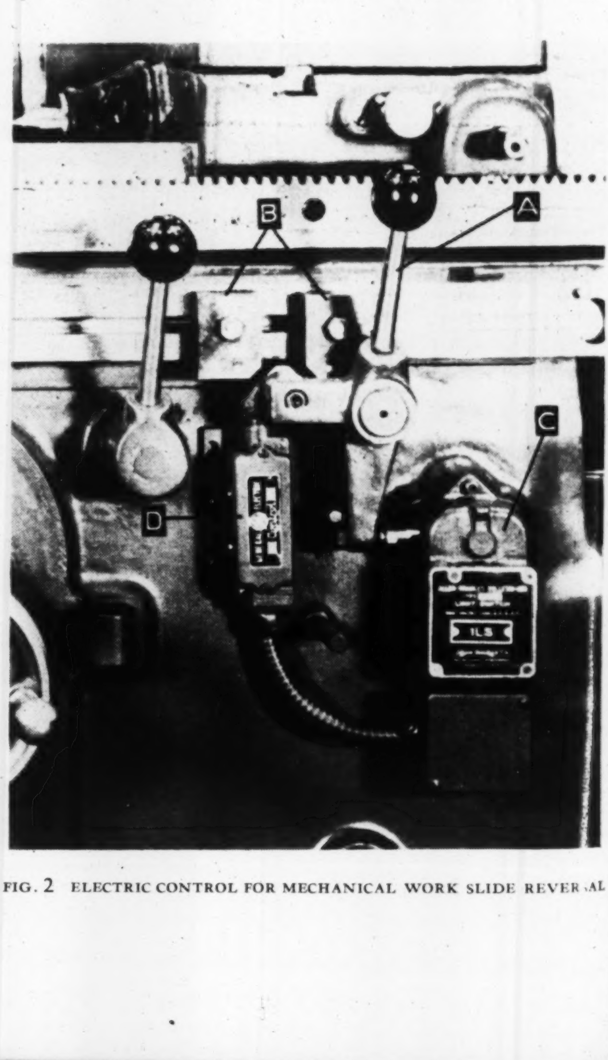

FIG. 2 ELECTRIC CONTROL FOR MECHANICAL WORK SLIDE REVERSAL

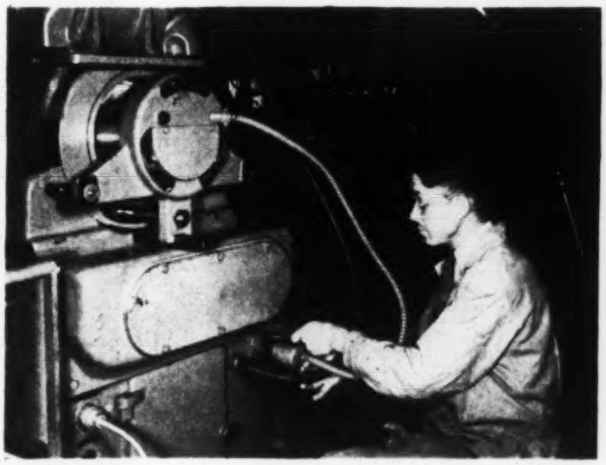

FIG. 3 REAR VIEW OF THREAD GRINDER SHOWING TRUING DEVICE

reach to avoid unnecessary confusion. Those shown on the operator's panel are a work stop button, a jog button, an indicating light showing when the wheel is being dressed, a truing selector switch which allows automatic dressing, manual dressing, or no dressing at all, a wheel start and stop button, and a cycle start button, which is normally the only element the operator uses in starting the machine for each automatic cycle of operation. An ammeter, graduated in percentage of wheel motor load, is provided. This is useful in determining correct wheel performance as shown by variation in motor load. Other elements, such as selector switches, which may be used at the time a change in setup is made, are located near or on the main operating panel. This position saves a great deal of wiring and is convenient enough for occasional use.

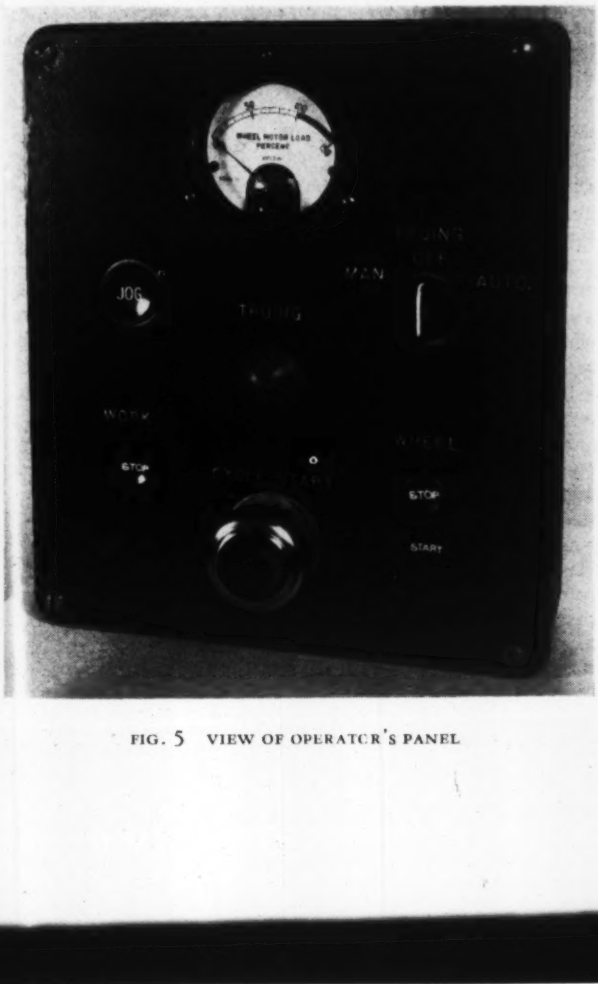

FIG. 5 VIEW OF OPERATOR'S PANEL

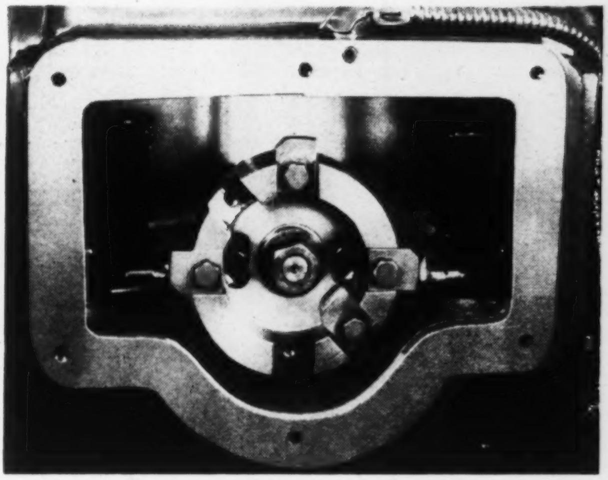

FIG. 4 DOG PLATE ON CAM-DRUM ASSEMBLY

AUTOMATIC FUNCTIONS OF A THREAD GRINDER

Fig. 6 shows a standard control panel for a 6 × 36-in. thread grinder. Every standard thread grinder built by the author's company has certain automatic functions which have come to be considered standard. These are as follows:

Automatic Machine Cycle. This means that once the machine is set up, a cycle of operations will occur which will be repeated until a change of setup is made. This cycle is initiated by pressing the cycle start button manually, and continues until the piece is ground to finish size, after which the machine stops automatically. The start and stop are controlled electrically.

During this cycle many things happen, all electrically controlled.

(*a*) Work slide reversal.
(*b*) Wheel dressing.
(*c*) Wheel slowdown for dressing.
(*d*) Work feed.

On the control panel it will be noted that there are two selector switches. One of these is marked "Wheel Slowdown," "On" and "Off." The other is marked "Grinding," "One Way," and "Two Way." The first refers to an automatic function of the machine which enables the operator to select a slower wheel speed at the time the wheel is being dressed. In most cases the wheel is slowed down for dressing automatically by setting the selector switch at On. This saves wear on the diamonds. Some jobs, however, require that the wheel be dressed at grinding speeds. When such a condition exists the switch is set at the Off position.

There are also two different ways of grinding a thread. One is to grind in one direction, withdraw the wheel, return it at a high rate of speed to the start, feed the wheel in again and take another cut. That is known as "one-way" grinding. The other method is to grind it in both directions or "two-way" grinding. Each method has its advantages, but each requires a different adjustment of the electrical devices. The selector switch determines which type of setup will be used electrically.

Fig. 6 has been mentioned to show the normal functions of any control, that is, the starting equipment for the various motors on the machine, of which there are five. This section of the control is shown by *A*. That portion of the panel devoted to the automatic functions of the machine, such as automatic start and stop, automatic dressing, and automatic reversal, is shown by *B*. It can be seen that only a small portion of the panel is required for the sequence control of the automatic

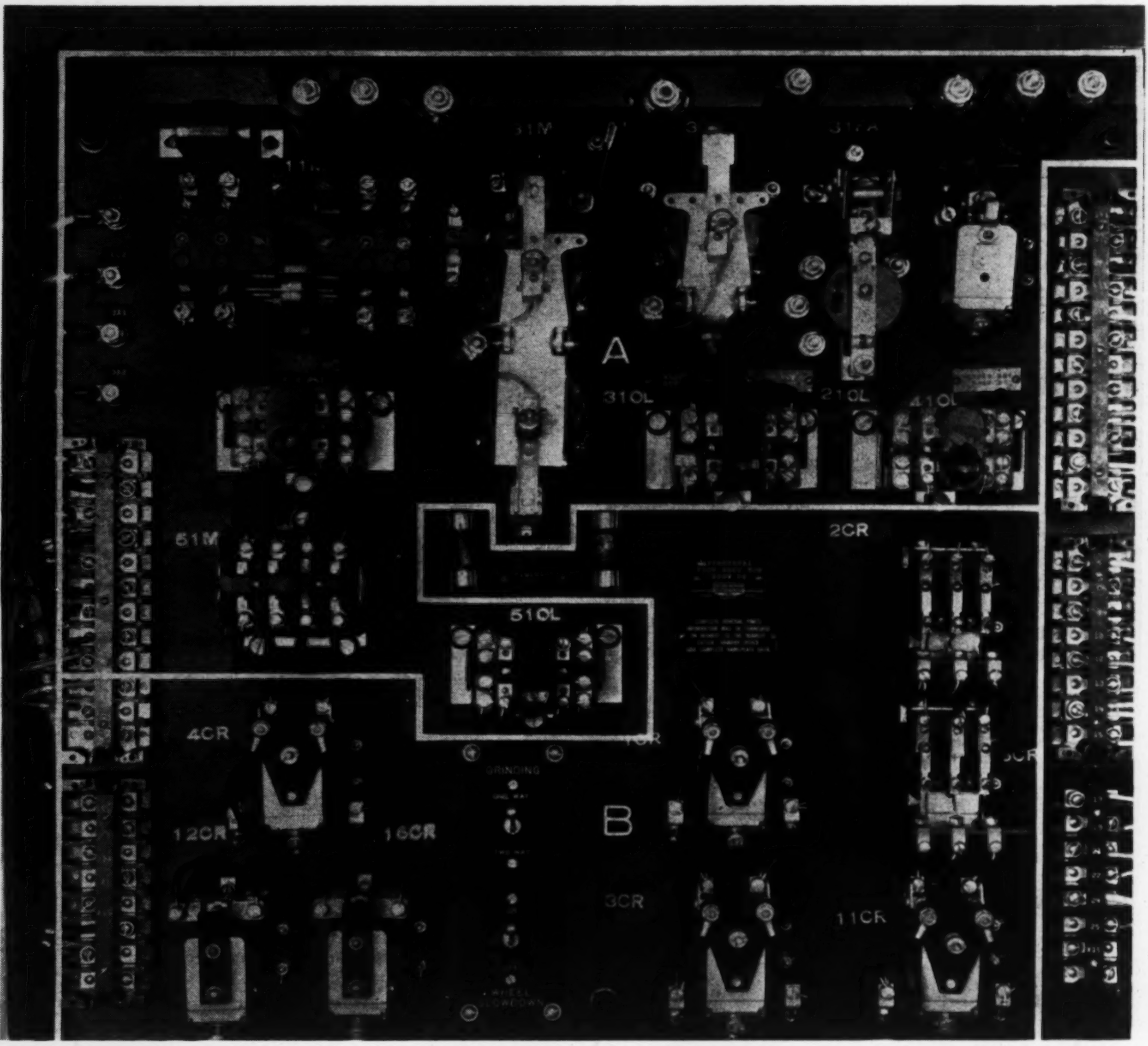

FIG. 6 STANDARD CONTROL PANEL FOR 6 × 36 THREAD GRINDER

functions outlined. These controls are considered basic in every thread grinder that we build. To them we add other devices to perform special jobs to suit customer's requirements or to meet new needs.

Fig. 7 shows a 12 × 45-in. thread grinder equipped with a 20-hp wheel motor for grinding threads on the ends of rock drills used in drilling oil wells. In this case we have a larger wheel motor which requires heavier starting equipment, for which we provide a floor-mounted enclosure to allow more space.

Fig. 8 shows a close-up of the control panel. It can be seen from this that the automatic equipment used in order to make the machine perform in a normal manner requires no greater area than it occupied on the control panel shown in Fig. 6. This can be seen in area *B*.

CONTROLLING A MULTIRIB GRINDER

There has been an increasing demand for so-called multirib grinding equipment. This differs from the single-rib grinding of threads in that a wide wheel is used which is similar in form and in function to a thread hob. This wheel carries a series of ribs of correct form and spacing and enables the user to grind a thread in one and a fraction revolutions of the work rather than by the traverse method described previously. A special design of truing device is required which can be adapted to any standard machine merely by plugging it into the receptacle mounted on the machine base. Ordinarily, more power is required to drive such a grinding wheel, so, as in the case of the job previously shown, a floor-mounted enclosure is specified.

Fig. 9 shows a machine so equipped. It can be seen from this view that the machine was built especially for axle shafts and rear-axle housings. The control equipment is much the same as that shown in the previous view except that the control of the length of work travel has been transferred from the work-travel dogs on the front of the slide to a special feed-in mechanism which is mounted on top of the slide. The work stroke is so short on multirib grinding that we were unable to find a limit switch which would be sensitive enough to operate under

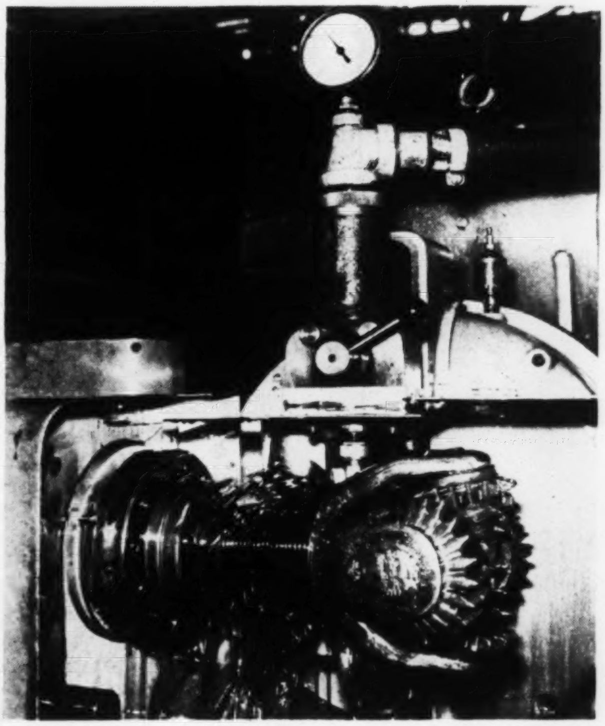

FIG. 7 12 × 45 THREAD GRINDER EQUIPPED WITH 20-HP WHEEL MOTOR FOR GRINDING THREADS ON OIL-WELL ROCK DRILLS

those conditions and at the same time be rugged enough for manual operation. Also, a different type of feed was required which would plunge the wheel rapidly into the work so that the thread could be ground in the least possible time. Normally this takes a third to one half a revolution, after which the work traverses one more revolution to complete the thread to full length.

Fig. 10 shows this in-feed mechanism as applied to a standard grinder and indicates the location of the limit switch *A*, on the top of this mechanism which enables us to control the length of stroke no matter how short. The dial carrying the limit-switch trip dogs *B*, must travel a certain number of degrees of an arc regardless of the movement of the slide. For instance, if a multirib thread of 40 pitch is to be ground, the slide would move only about 0.035 in., whereas if an 8-pitch thread were to be ground, the slide might move 0.160 in. to 0.175 in. However, the rotation of the plate carrying the trip dogs would be nearly the same in either case so this setup was simplified materially by transferring the machine reversal from the work slide to the feed-in attachment. This is done by means of a selector switch on the main panel. When shifting from multirib grinding back to single-rib grinding, the operator turns the selector switch back to "single-rib" position and disconnects the mechanical linkage between the feed-in attachment and the work slide. It is not even necessary to remove the feed-in attachment from the work slide, as the limit switch is no longer operative.

AUTOMATIC INDEXING HEADSTOCK

An automatic indexing headstock was designed for use on new and existing machines. It is used in grinding round-thread rolling dies, worms, and multistart threads. Here was a case where electrical controls enabled us to adapt new equipment to a standard machine. This new headstock needed to be automatic in operation if it was to follow the design standards already established. The automatic operations required are as follows:

(*a*) Automatic indexing for a wide range of starts.

(*b*) Automatic feed only after one complete revolution of work of predetermined number of indexes.

(*c*) Automatic dressing when required either before or after finish cut.

(*d*) Automatic stop after all indexes and predetermined number of cuts.

Fig. 11 gives a view of the floor-mounted control panel used on this machine, in which the *A* section shows the panel area devoted to standard motor controls; *B*, the standard automatic controls; *C*, the controls for the automatic indexing headstock; *D*, a counter which is set for number of indexes required per revolution, any number from 1 to 60. Its function will be described later. The indexing mechanism is driven by a small

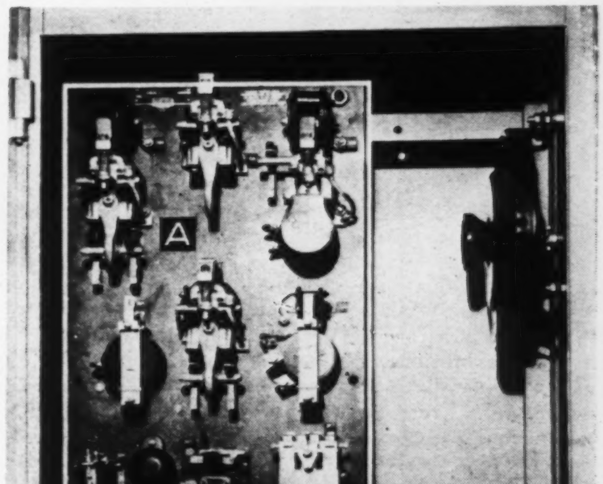

FIG. 8 CLOSE-UP OF CONTROL PANEL FOR ROCK-DRILL THREAD GRINDER

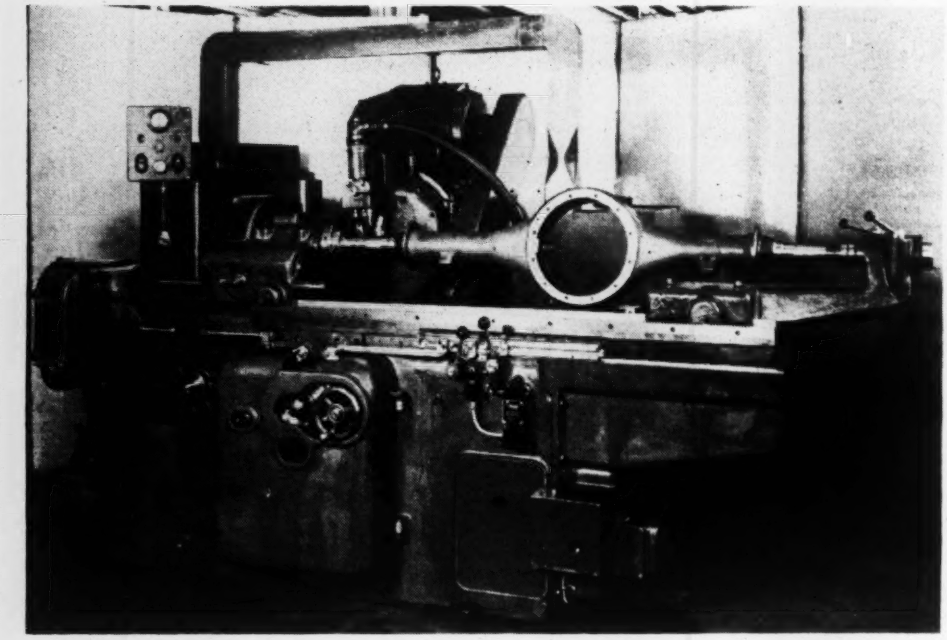

FIG. 9 FLOOR-MOUNTED ENCLOSURE FOR MULTIRIB GRINDER CONTROLS

$^1/_3$-hp motor. The design calls for a quick stop by this motor. Two methods are available, either through magnetic braking or plugging. Both have been tried. At present we are plugging the motor because we have found this method more uniform under all conditions. While this takes more control equipment, the results are believed to justify it. The other devices are used for the functions previously described.

Let us assume that we wish to grind a 6-start worm previously roughed out. Experience has shown that three roughing cuts and one finishing cut are required to bring the piece to finish size. The operator sets the automatic wheel feeds of the machine in the usual way to insure proper rate of stock removal. He then sets counter *D* to the required number of starts, in this case 6. The counter controls both wheel feed and diamond dressing, making sure that they take place only after one complete series of indexes, in this case 6. The machine setup calls for one-way grind. When the wheel has been matched properly with the roughed-out blank, the operator presses the cycle start button, and the worm blank rolls by the wheel on the first cut. The wheel is then withdrawn. The work returns on the fast traverse to the starting position. Work rotation stops while the machine indexes $^1/_6$ revolution, after which the operation is repeated. This continues until six indexes have been made.

Fig. 12 shows the added controls required on the front of the machine. Wheel feed, mechanically operated, has been called for after each pass. This feed has not operated because of latch X which has locked the feed mechanism. However, after the sixth index, solenoid *Y* has pushed the locking lever out of the way so that a normal feed can take place; all under control of counter *D*. This operation is repeated after every sixth index, until the end of the sixth finish cut. The standard automatic stop then ends the cycle. Automatic truing ordinarily is called for between the last roughing cut and the six finishing cuts. In order to make sure that this takes place at that time, a solenoid *Z* is used to operate the truing release lever *M*, in place of the usual mechanical trip. This function is also controlled by counter *D*. As a further refinement, we use existing controls to provide for an index at either or both ends of the stroke. In grinding right or left-hand worms, this choice may be important. If two-way grinding is required, we usually index at each end of the stroke.

Fig. 13 shows the automatic-indexing headstock with the front cover removed. Change gears are shown which determine the number of mechanical indexes per revolution. All indexing rotation, regardless of the number of starts, is brought to a stop against a one-tooth stop cam and a solenoid-operated latch. This insures an accurate stop and eliminates the difficulty so often encountered in building and maintaining accurate ground index plates. A selector switch is added to the control panel, marked "single start" and "multistart." If single-start work is called for, this selector switch makes all multistart electrical controls inoperative. The headstock itself is connected electrically to the control panel by means of a plug-and-receptacle arrangement similar to that used with the truing device. In some case the automatic-indexing headstock is removed and replaced by the standard one. In our own plant the indexing headstock goes from one department to another as the need arises.

ADOPTING STANDARD EQUIPMENT TO SUIT SPECIAL NEEDS

As an indication of what can be done electrically to change standard equipment to suit special needs, a job presented to us recently will be described. A customer asked for information regarding a standard machine equipped with automatic indexing. When his drawings were submitted, it was discovered that several of the worms were blind on both ends. This meant that we no longer could run out of the worm for indexing. Instead, we had to withdraw the wheel completely from the work during that cycle. This required the following as additional machine equipment:

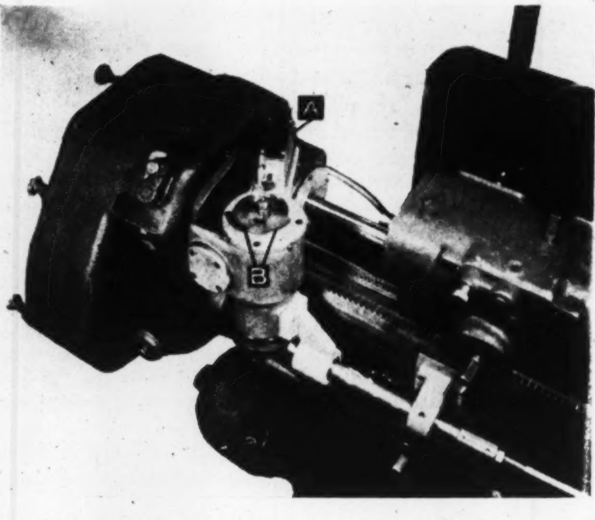

FIG. 10 IN-FEED MECHANISM APPLIED TO STANDARD GRINDER

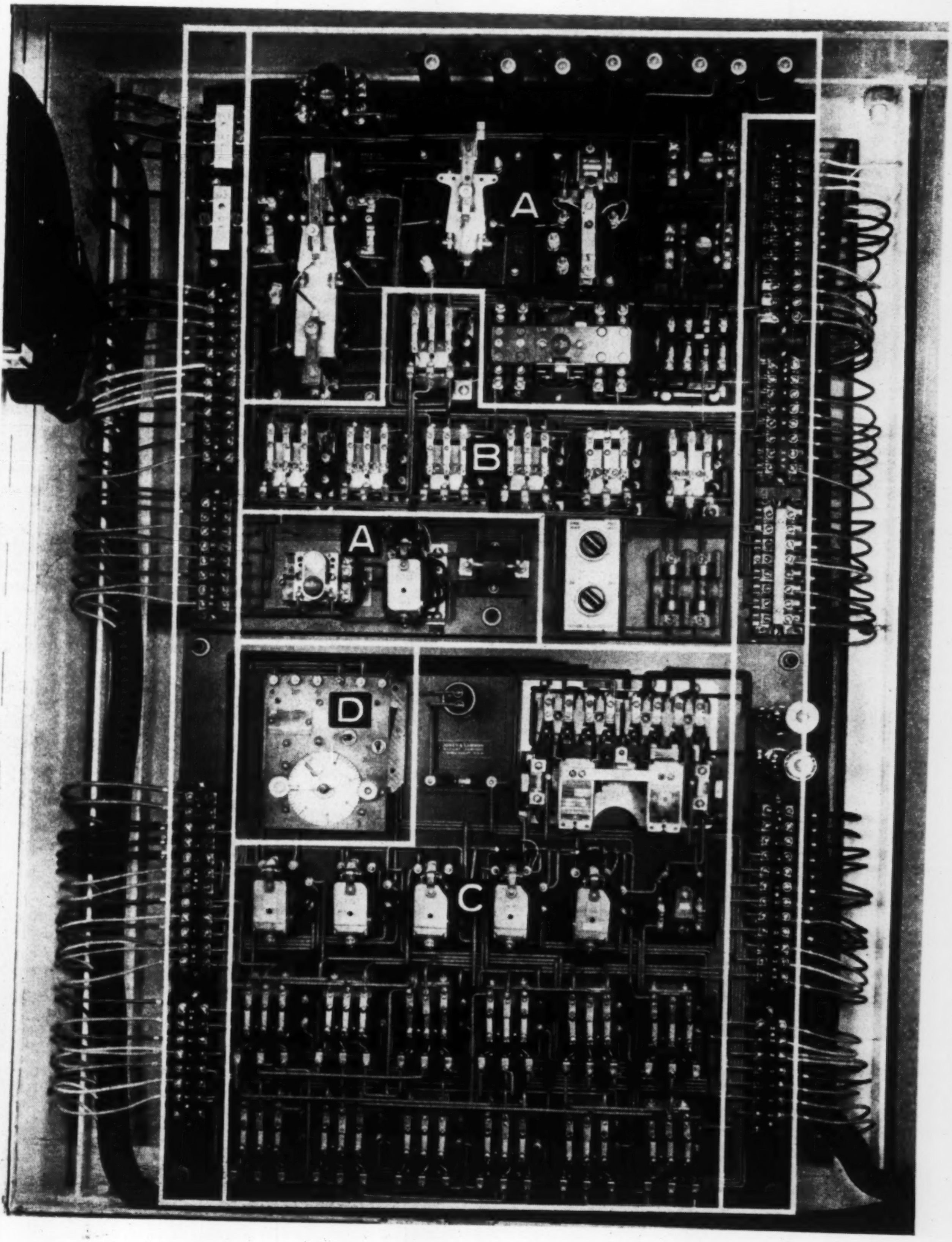

FIG. 11 FLOOR-MOUNTED CONTROL PANEL FOR AUTOMATIC INDEXING HEADSTOCK

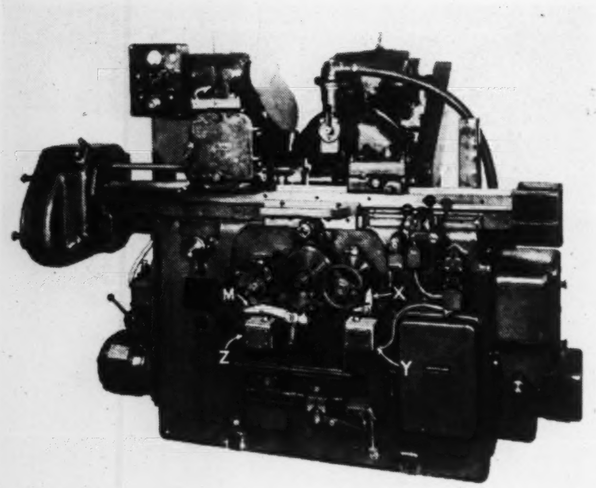

FIG. 12 ADDITIONAL CONTROLS REQUIRED FOR AUTOMATIC INDEXING

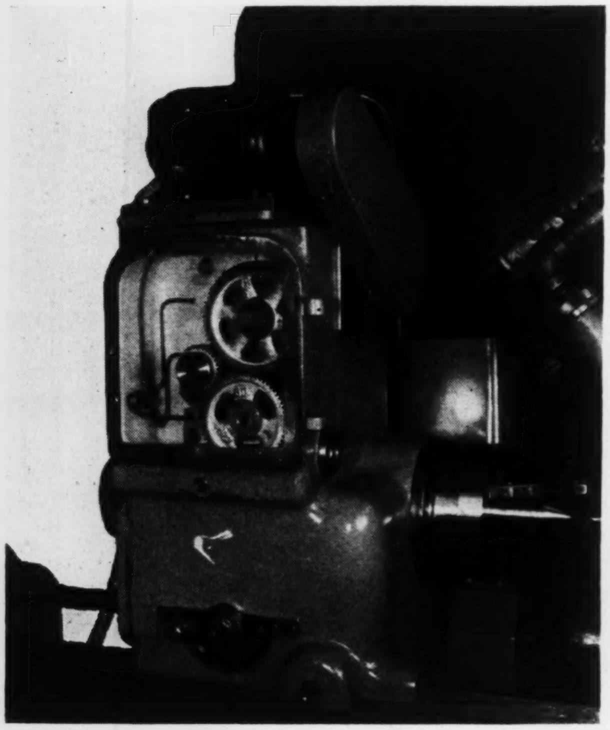

FIG. 13 AUTOMATIC-INDEXING HEADSTOCK WITH COVER REMOVED

1 A simple hydraulic arrangement for wheel withdrawal, as the standard amount of automatic back-off was insufficient.

2 A small motor-driven pump to supply oil pressure to the hydraulic devices.

3 A two-way hydraulic valve, solenoid-operated.

The grinding operation was the same in this case as in that just described, except for the extra wheel withdrawal. After indexing, the wheel is returned to the grinding for the next pass through. To accomplish this we added the following devices to the control panel:

(*a*) One selector switch.

(*b*) Three relays.

(*c*) One overload relay.

These are shown in area *E*, Fig. 14. Thus it was possible to grind the special worms automatically. We were also able to make this special feature inoperative when not needed, simply by turning the selector switch to the off position.

CONCLUSION

Many other electrical control equipments of a special nature which are doing good work in the field could be mentioned; for example, the controls required for automatic in-feeds in plunge-grinding and those for crush-dressing. For the most part, these controls require little servicing, particularly when they are well housed in dustproof enclosures.

Quality in devices and panel constructions is just as important as it is in mechanical construction. It is essential that these controls be supplied with a stable source of current. Voltage fluctuations of more than 10 per cent may lead to erratic operation of the controls.

Mock-ups of new circuits can be made quickly and easily for test purposes. A rough board, a pair of pliers, and a few lengths of wire will enable the electrical engineer to try out new ideas cheaply and conclusively. While many electrical devices seem cheaply constructed, it is a mistake to judge them on that basis alone. Tests have shown that it is possible to operate them hundreds of times a day, month after month, with unfailing precision.

It is felt that the machine designer should always consider electrical controls when designing new automatic equipment. In doing it he should think of them only as tools which may make design better, simpler, and more reliable. The design of a complete electrically operated machine requires close co-operation between the electrical engineer and the machine designer.

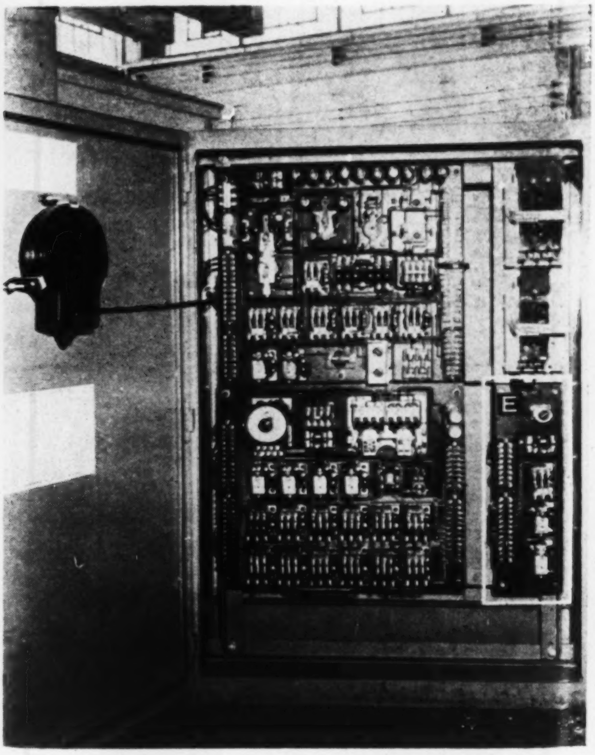

FIG. 14 CONTROL DEVICES ADDED TO STANDARD MACHINE FOR AUTOMATIC INDEXING

"AUTOMATION"

By N. L. BEAN

DIRECTOR OF PRODUCTION ENGINEERING, HIGHLAND PARK OPERATIONS, FORD MOTOR COMPANY, HIGHLAND PARK, MICH. MEMBER ASME

DEL. S. Harder and Mead Bricker, vice-presidents of Ford Motor Company, sat in a meeting with some of their top production men discussing high production problems. Mr. Bricker had asked for means of handling parts in process of manufacture, without some of the delays often incurred due to the human element.

"That's right, 'Brick,' what we need is more automation," remarked Mr. Harder. After returning to our offices a hurried search of Webster's Unabridged Dictionary soon proved that Webster did not mention "automation." A new word was coined and an engineering section devoted entirely to automation soon became a reality.

PUTTING "AUTOMATION" TO WORK

New talent was sought through the medium of the employment office. However, What do you know about automation? had most of the applicants confused. By exercising patience and careful screening, men of excellent qualities and overactive imaginations were assembled in this Automation Section of Mechanical Design.

The most important items immediately in need of automation naturally would be parts which were produced in extremely high production numbers. Most desirable would be parts where several would be required per car unit.

The valve, valve guide bushing, pistons, connecting rods, and such parts were considered for improved handling methods. The valve guide bushing, an iron casting, seemed a logical part. Production was to be in excess of 100,000 pieces per day, and the castings were small and not too difficult to handle. However, later on we were to find that this conclusion of "not being too hard to handle" was somewhat hasty.

When the valve guide bushing was selected as an automation guinea pig it was made in two identical halves. Production tolerance was so close that any two halves placed together would maintain a total manufacturing tolerance of 0.0004 in. on the inside diameter.

At about this time the Engineering Department changed the design so that the bushing was solid instead of being halved. However, dimensionally the single bushing remained the same as two halves placed together.

The valve guide bushing is an iron casting approximately $2\frac{1}{4}$ in. long. About half of this length is 1 in. diam, while the other half is approximately $\frac{5}{8}$ in. diam.

AUTOMATION APPLIED TO VALVE GUIDE BUSHINGS

The nearest approach to complete automation is this Valve Guide Bushing Department. From the first machine operation right through all operations including automatic inspection, practically all work is carried on automatically. In sequence, the drilling, reaming, forming or turning, facing, grooving, boring, and finish-grinding are all done without human handling.

This conveyerized department is responsible for producing all of the Ford 6- and 8-cylinder as well as the Tractor valve guide bushings.

These castings are received from the foundry in large rectangular steel containers. A special lift-type transporter hauls the container from the receiving dock to the department, and raises it about 7 ft in the air. By means of a special rotating unit the container is revolved 180 deg and dumps the contents into a large inverted pyramid-shaped bin. This bin is about 6 ft square and about $4\frac{1}{2}$ ft high. The sides taper about 30 deg, and a continuous cleated belt conveyer carries the valve guide-bushing castings from this bin up an incline into an agitated-type hopper which supplies an even flow to a double-ended grinder for the first operation in the machine line-up. Both ends are ground, and an over-all tolerance of 0.010 in. is maintained.

Conveying Bushings Through Grinding Operations. There are four grinding lines which precede the machine operations. At present the double-ended grinder is loaded manually by placing the bushings in notches around the diameter of the rotary carrier fixture which holds the parts while they pass between two disk wheels. These are medium-grade resinoid-bonded aluminum-oxide abrasive disks.

The parts are ejected onto an inclined conveyer and into a hopper which feeds them end to end in a continuous line through a centerless grinder, where about 0.020 in. is removed from the outside diameter. As the bushings are being prepared for entering the first OD centerless grinder, they lie in a V-type chute end to end and on about a 40-deg incline.

Gravity provides propulsion to the grinder; however, some sort of timing or control must be used. This timing is done by a rubber wheel which is approximately the width of the bushing. A groove has been formed in the outer periphery comparable to the radius of the bushing diameter for further betterment of contact of the bushing against the wheel. This rubber wheel compresses slightly against the bushings and acts as a retarding agent. The wheel rotates at the identical feed rate of the centerless grinder.

Leaving the first OD grind, the bushings are carried up another incline into a hopper, and the same procedure is repeated of continuous feeding through a second grind for 0.015 in. removal from the outside diameter.

This operation is repeated for a third grind for 0.009 in. stock removal and again for a fourth or semifinish grind, this time removing about 0.003 in. of stock from the outside diameter.

The bushings are spot-checked for size, taper, run-out, etc., on each line, and the centerless grinding wheels are dressed daily.

Continuous Washing Process. Every movement is mechanized and requires no human effort other than a spot inspection to see that quality is maintained. The feed through the semifinish-grind operation continues moving the bushings until they fall gently on a mesh conveyer, which is a part of a continuous washing machine. Passing through this machine, numerous jets of alkalized hot water play on the parts and thoroughly wash away any foreign particles, dirt or grease. The heat that is retained from the hot water acts as a drying agent, and when bushings emerge from the washer they are practically free from moisture.

Turning and Boring Machines Loaded Automatically. Reaching

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the end of the washer, the bushing falls a short distance onto a rubberized conveyer which carries the parts to a battery of 15 turning and boring lathes.

Automation now becomes a real factor. Each machine is loaded automatically from a tube-loading device. The conveyer extends from the automatic washer to the last of the automatic lathes. Stock is supplied to each machine with an automatic hopper feed. These hoppers are kept filled to capacity by means of by-passing deflectors or gates which divert a portion of the bushings to a chute into the hopper. When a hopper is filled, the gate closes and the bushings continue on to another hopper not yet filled. The weight of the hoppers controls the gates and either permits the bushings to enter or to be sent to an unfilled hopper.

The hoppers are supported on each corner by four springs. When the hoppers are empty, the springs have but little compression and rise about 3 in. higher than when full. Inasmuch as the bushings leave through a flexible tube, no complications arise because of this variance. As the hopper becomes filled, the springs compress. When the hopper reaches a low point, which denotes that it is filled to capacity, a switch is contacted and trips, actuating the gate or by-pass deflector on the conveyer overhead. If all hoppers should be filled at one time a danger light would signal this obstructed condition.

The hoppers keep a continuous supply of bushings going up a twisted chute where a pusher shoves the stock through the hollow spindle entering the chuck. A stop positions the bushing and a trip lever causes chuck jaws to clamp the part firmly.

Just before being pushed through the hollow spindle, from the back of the machine, the bushing rolls down a short angular chute, which, when filled, causes any surplus stock to roll out and back into the hopper.

This safety feature provides for an excess amount of bushings to enter the magazine chute, however, it disposes of any overamount to return to the starting point or hopper.

The drills on these machines are changed at the end of each 8-hr run. The turning tools are carbide-faced and are fed at about 0.006 in. per revolution.

Outside turning, grooving, and rough-boring are done in these automatic lathes at a rate of about 6000 pieces per hr, or approaching 100,000 pieces per two 8-hr shifts; or to carry it further, about 2,000,000 pieces per month. The only manual operations here are periodic checks for machine setup and quality.

Finish-Grinding. After being ejected from the automatic lathes, bushings slide down a chute to a rubberized conveyer which carries them to a battery of grinders for a finish-grind operation.

This operation sizes the outside diameter to 1.0306–1.0301 in., allowing only 0.0005 in. tolerance. Although producing this 100,000 pieces daily, this tolerance is maintained with practically no scrap. An amplifier gage furnishes the means of setup checks to hold this continued accuracy.

A 100 per cent check is not attempted until all operations, excepting plating, have been completed.

Directional Selection of Bushings. As the bushings leave the grinder they travel up a slight incline to gain height for a very unique directional selection. This system is designed to fill trays which are fitted end to end so closely that they practically form a continuous conveyer. Each tray has four rows with seven openings in each row to hold individual bushings. The heavy end of the bushing must enter the tray first with the stem or neck ends sticking slightly above the ribs which form the rows and act as separators.

As the bushings slide down this incline, they enter a tube with no attention paid as to which end comes first.

This mechanical brain accomplishes directional placement by a simple yet effective means. The shape of the bushing, being large on one end and small on the other, creates an unbalance which is the governing factor. This also places the center of gravity about one third of the length from the large end.

An opening has been cut in the bottom of the tube, wide enough for the bushing to fall through but only half the length of the bushing. When the heavy or large end of the bushing is toward the front, it overbalances and tips downward as soon as it passes one third of its length over the opening. The neck, not having cleared, straightens the bushing, neck upward, and permits it to fall vertically into the tube leading to the trays.

When the small end of bushing comes down the incline first, the neck rides completely over the opening and rests on the far side. As the bushing continues its forward motion, the heavy end falls through the slot and the neck riding on the front edge of the opening again tips the bushing and causes it to follow down the vertical tube.

A positioning or metering device selects and fills the trays so that all four rows have been properly loaded. The trays are bottomless and the bushings ride on the conveyer base. As the trays travel through a washer, multiple jets spray from all directions.

There is a steep incline inside the washer so that trays enter quite low but leave higher than a man's head.

Functions in Final Boring Operation. The bushings are now ready to go to the final boring machine, and automation again comes into play. The conveyer at this point is about 4 ft higher than the magazines of the precision boring machines.

Gates in the bottom of the conveyer are solenoid-operated and function only when a bushing is immediately over the opening and when the tube is ready to receive more stock. The feeding of stock through these tubes into the two magazines of each machine is quite simple as escapement levers operate solenoid trips in proper timing sequence.

Air-operated plungers position the bushings into double diaphragm chucks through hollow spindles. The stock enters the rear of the machine and is located with plungers which withdraw automatically before the boring cycle starts.

The solid tungsten-carbide boring bars have brazed carbide tips, and the cutting pressure causes a slight spring in the bar on the inward stroke. On the reverse or outward stroke, the feed is reduced and the springback furnishes the axial pressure for a very fine finish cut.

This method is precision-controlled and the bore is held to within 0.0005 in. of desired size and within 0.0015 in. total indicator reading on concentricity with the outside.

There are two 5-station double-fixture rotary vertical machines, and ten 2-spindle horizontal boring machines. The ten machines have automation, but the two rotary vertical machines do not lend themselves to automatic feeding, therefore, they are manually operated.

When the bushings leave the finish-bore operations, they fall into another tray-loading unit similar to the one on final grind.

Final Washing and Inspection. The tray conveyer sends bushings through another washer and then drops them into tubes leading to an automatic inspection machine, which functions with near-human performance. This inspection unit indexes so that the various stations have sufficient time to go through the various checking cycles.

Bushings are fed through two vertical tubes. The large or heavy end of the part enters first. The tungsten-carbide-tipped gages check inside diameter for size, out-of-round, and taper;

(*Continued on page 394*)

An INDUSTRIAL *Point of View* *on* CREATIVE ENGINEERING

By T. E. SHEA

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WHAT do we mean by the term "creative engineering?" Discussions of this subject are replete with such words as, ingenuity, inventiveness, inspiration, intuition, instinct, originality. Emphasis on these words could seem to indicate an oversimplification of the problem, or rather concentration on certain phases of it, although of course it is healthy to stress the fructifying part of the process. But there is a great deal more to the problem.

The remarks that follow will to a large extent involve personal opinion. They will be influenced by my make-up, temperament, experiences, associations, and philosophy of life.

I would define creative engineering as that which results in significant advances in the application of scientific knowledge to the useful purposes of mankind.

This definition stresses the result obtained, rather than the means used. As will be seen later, more is required than inventiveness, and the terms originality and ingenuity acquire broad meanings.

Now I think that in industrial work the days of relatively unassisted effort are largely gone. There are several reasons for this.

Primarily, major developments and inventions of past generations often took place in the face of large gaps in scientific knowledge, or under conditions of inadequate availability of such knowledge. To say this is not to minimize the great worth of these developments and inventions to society. Partly because of the recognized value of major and lesser advances, the ground is better fertilized today. Technologists of all kinds in great numbers are working at the orderly processes of applying scientific knowledge, and the combined effort of these technologists is terrific in volume. The result is that comparable developments and inventions today commonly take place in a setting of comprehensive scientific knowledge.

It is as if, for example, one should have little expectation of the fortuitous finding of oil fields, because of the vast amount of exploration which has been done, the modern scientific methods of exploration, and the basic generalizations which now exist as to the probability of occurrence of such materials under analyzable and recognizable circumstances. Or one might compare the strivings of the oceanographer, the meteorologist, and the ecologist with those of the early explorers.

This, I repeat, is not to minimize the importance of past developments and inventions. It is to indicate that times have changed. It is to indicate that society has found a way to help designers and inventors, to surround them with knowledge, to make them more productive and more objective, to make use of greater numbers of related acts of inductive thinking, and thus to make speedier progress toward its goals.

The very fertility of science creates its own problem—one almost of overpopulation of facts and ideas. The complex needs of our industrial civilization, the highly developed character of the industrial machine, often the need for fitting improvements into a heavily capitalized long-lived system of equipments, and the abundance of applicable techniques in many specialized fields make it necessary that new designs, new developments, new inventions be fitted into a kaleidoscopic pattern of what I shall call "consumer requirements." Consumer requirements means the total of the economic, technical, and operating requirements necessary to fit an item into the system of which it is to be a part. By system is meant the manufacturing, maintenance, installation, and operating facilities and procedures which have a bearing on the manufacture, the use, and the life of the item.

Accordingly, it becomes necessary that the efforts of designers and inventors be supplemented by those of other persons, many of whom are also truly creative. Of all the things I know about engineering, I am most humble about the sheer inadequacy of any one man in knowing all that he should know; a lifetime of diligence in learning leaves him still woefully ignorant; and he becomes most knowledgeable in his later years when, whether due to bodily limitations, pressure of social obligations, dwindling of intellectual effort, or a greater interest in younger men and a tendency to work through them, he is less likely to be inventive in the conventional sense. These are some of the reasons why group effort takes the place of more individual effort, and why we should concentrate on problems attending group creative engineering as well as on those of the development of individuals.

Then too, there are factors which operate to limit the supply of inventors. To the extent that avenues of knowledge to satisfy the yearnings of an inventor are more readily open, to the extent that good experimental equipment and intimate association with kindred spirits attract him, and to the extent that his inductive powers can be used in other fields, inventive abilities may be turned in other directions. I believe that in pure science there are many people who could have been outstanding inventors. I believe that in engineering development work many people are exercising the same sort of talents in formulating, judging, stimulating, and steering group effort. Their results are also broadly creative.

QUALIFICATIONS FOR CREATIVE ENGINEERING

With this setting, I should like to offer some comments on the qualifications necessary for creative engineering. They include the following:

1 Motivation.
2 Inductive ability.
3 Scientific knowledge (which includes memory).
4 Self-criticism.
5 Balanced judgment.
6 Exacting standards.
7 Group adaptability.

Of course, these qualifications exist in various men in differing proportions.

As to motivation, psychologists ultimately may find out what drives creative engineers. I am unsure about this but think I

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see something of a pattern. The great stream of knowledge flowing from science through engineering into useful results is a part of the life processes of our civilization. But it is a stream which does not flow downhill by gravity; it is pumped on and on uphill by people. To be in that stream and to be one of the pumpers is to be a part of those life processes, to be an agent, as it were, of Providence. It is one of the curious results of creative work that the thing created truly becomes part of the engineer and he of it. The result is "his"; even in group activity it is "his and theirs."

Viewed in this way, creative engineering is neither a job nor a position. It is fortunate that people pay for the results of creative engineering so that men may have livelihoods, but if pay were all, there must be easier ways of earning a living. To the extent that good pay avoids concern about economic worries and evidences prestige and recognition of values, it is a powerful source of motivation. To the extent that prestige and regard can be shown in other ways, these too will contribute to motivation. In general, I believe that the free enterprise of our society sets such a high value on creative results that it contributes strongly to motivation.

As I see the student output of colleges and trade schools, there are many who have not the necessary motivation. Of course, industry has many jobs for those who wish to be or must be merely technicians, and there are many types of industrial work where this kind of motivation is not required. I have noticed in the literature many observations on the desirability of recognizing creative ability at any early stage. Whatever schools can do to fertilize this ability through motivation is equally important. In this connection, it seems to me that there is a shortage of creative teachers as well as of creative engineers.

By creative teaching I do not mean engineering drilling. I mean the conveying of insight into the life processes of which I speak and into the satisfactions to be had from participating in them. I do not recall many such teachers, but their influence was great.

One instructor in charge of dynamo laboratory work (Prof. C. W. Ricker) offered credit for three experiments to anyone who would devise a worth-while original experiment. We had been running so-called "pumpback" tests on motor-generator sets. I conceived the idea of running a pumpback test on a single lap-wound direct-current machine by making half of it as a motor work the other half as a generator. We thought this was original. It doesn't matter whether it was or not; the important thing is that it was original to me. I suppose I put an effort into the experiment equivalent to that of ten ordinary experiments, and was happy to do so. For one of the few times in my undergraduate work I caught a glimpse of the creative process. There was the feeling, "Perhaps you, too, can do this sort of thing well."

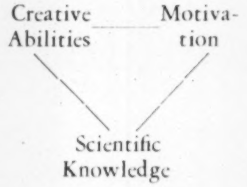
Prof. Edwin B. Wilson was a remarkable teacher in the inspirational sense. In a course he gave in mathematical physics we solved comparatively few problems; indeed, he seemed to like to give us problems which were very difficult to solve. He had a habit of setting up a difficult problem on the board, cocking his feet on the desk, and saying, "Now how would Lord Rayleigh go about solving that?" When a Rayleigh approach had been tried and had failed, he would perhaps say, "Well, that doesn't work. How would Larmor have gone about it? Let's try his tack." A succession of approaches would finally give a solution.

Wilson drove home to us that even great physicists had their particular tools and approaches and their limitations, that failure in one approach should lead merely to casting about for another approach, and that success depended on persistence and ingenuity in finding the right path.

We were admitted as very junior members into the company and the thinking processes of great men. We were shown that they, too, were merely human. Though this course was largely analytical in character, the groping for solutions was often largely inductive.

It is easy to see in retrospect that textbooks have culled out the evidences of the struggle to find out what works and what does not.

I carry in my mind a picture of a triangle which relates creative abilities, motivation, and scientific knowledge. It applies not only to individuals but also to groups. Indeed, the group not only strengthens each of these factors but also the bonds between them.



THE DESIRE FOR KNOWLEDGE

The making of balanced judgments depends on the possession of scientific knowledge. The possession of knowledge in turn depends on motivation. The demands in knowledge of creative engineering are enormous. In order for men to have sufficient knowledge, they must, to imitate Gertrude Stein, want want want to learn. Too many people expect to be instructed. Men who have taken their place in industry should be basically capable of learning by themselves. Orientation courses, formal lecture courses and similar devices have their place but they run into limitations. One highly valuable aid is the rotating of promising men through a variety of jobs to give them new experience and a breadth of point of view. The compulsions and stimuli toward learning, of the impacts of associations with colleagues, are perhaps the most important factor in industrial learning. But it is up to the individual to do the learning.

I have attended few formal lectures in twenty-five years but circumstances have required me at various times to become more or less acquainted with transmission, electronics, acoustics, photographic recording, central-office switching systems, antisubmarine detection and ordnance, submarine operations, manufacturing planning, quality control, and other fields. The young engineer who aspires to creative work must learn, after all, to learn by himself and to keep on learning. If colleges and industry can persuade him of that he will be the better equipped for his work.

However, one group of creative specialists, who are not sufficiently developed by society, are the mechanical designers. We appear to have to take mechanical designers pretty much where we find them. All too often they have traveled a road which has not given them the technical knowledge which would have made them better rounded and more useful.

At one time I was chairman of a design committee in a large laboratory. We were trying to find out things about designers. We collected information on 165 design engineers. About one half of them had degrees from engineering schools; the other half represented a variety of stages of formal education. Of those who had gone through engineering school, there was no pattern—there were mechanical engineers, electrical engineers, some chemists, and so on. Design work seemed to be somewhat like the playing of chess; if one had the ability, it was likely to pop out.

A professor of mechanical engineering at a noted school told me that if he got a good designer in his courses, the man would probably flunk out. "They generally have not," he said, "the ability to sit in an examination room for two or three hours and write what they know. They think in terms of pictures and three-dimensional images instead of words."

MECHANICAL DESIGN ABILITY SHOULD BE CULTIVATED

Now we all know fine designers who have not this limitation, but as a qualitative observation there is much to his remark. I have wondered whether this national asset—mechanical-design ability—might not be better treated; whether professional courses might not be designed to meet the needs of designers. In the architectural schools, we honor artistic ability. Should we not similarly honor mechanical design? Should we not have outstanding schools of mechanical design?

Industry, too, has a part in this problem, for unless the capable designer can be made well-rounded, he remains at the level of the specialist. The motivation for others to follow in his footsteps is less, if design ability appears insufficiently appreciated. The group operations which I will discuss later can do much to help. Rotation of jobs for purposes of experience is also valuable. In this connection, I would like to refer to a paper given before the Society in 1931, by J. L. Alden,[1] on machine-design management.

There has been much said in the literature about the working conditions under which creative engineering thinking takes place. People have spoken of the need for relaxation of mind to encourage inductive ideas to come into the conscious mind. They have spoken of the importance of inspiration and encouragement on the one hand, and of the driving force of frustration in inventors on the other hand. But the pattern of creative engineering work can be peculiar.

A comprehensive feat of creative engineering took place in the devising of weapons to counter the German submarines in World War II. In this work Division Six of NDRC had a leading part, and I am familiar with that part. Their effort involved well over a thousand scientists and engineers. It involved the slow painstaking development of the requirements and possibilities of the situation. Since detection is for the purpose of attack, since attack is for the purpose of destruction, scores of instrumentalities were required, some more essential than others but all of them needed. Ingenuity played a part even in the methods of use of weapons, for tactics can be clearly visualized only in terms of instrumentalities made available. The result, after three years of highly organized effort on a wide front, was an outstanding example of creative engineering.

Out of this experience, three things impress me most: (1) analysis and intuitive effort mutually served each other; (2) scientists turned engineer showed a high order of intuition on engineering problems (and we should not be surprised at this); (3) the motivation—that of self-preservation, made tangible in an effort to save young American lives—made work fruitful even under conditions of great fatigue. Almost complete preoccupation with the problem, and the driving force of working against time, seemed to push back the normal fatigue limitations of the human mind.

As an example, I remember one of the most original engineers in this country, who defied all rules about relaxation. On one occasion he showed me a model of a new device after he had worked all night to complete it. I do not recommend his methods to others. But I recall no diminution throughout the war in the fertility of his ideas or in his adaptability to quick change of problem.

Many other examples of group achievements in engineering during the war could be cited, in which the circumstances were similar. Of course, men could not perform thus, once the dire need was over. But in emergencies we may gain glimpses of our processes which would not appear in normal times.

It is because of experiences of this kind that I have become less confident about specific rules for a man's habits of work or his environment and more concerned about the fundamentals I have cited, i.e., motivation, inductive ability, scientific knowledge, self-criticism, balanced judgment, exacting standards, and group adaptability.

CREATIVE ENGINEERING THROUGH "GROUP OPERATION"

With these preliminaries behind us, I should like to describe the method of approach to creative engineering which, for want of a better term, I shall call "group operation." In Western Electric Company, Teletype Corporation, and other Bell System organizations with which I am familiar, the techniques of group operation have been developed to a high degree. In the NDRC efforts during the war, these techniques contributed heavily to success. The techniques (which are paralleled in other types of industrial effort) are a highly significant development of the past generation. They increase greatly the effectiveness of men, and are worthy of our attention as possibly the greatest source of increase in creative engineering.

I have spoken of the complexities of modern technical requirements, and of the vast amount of scientific knowledge of many kinds which must be brought to bear on individual problems. The individual becomes quite inadequate; the group, versatile, ever-changing, and flexible, becomes necessary.

Let us consider the steps involved in creative effort:

1 Find the problem—appraise its importance.

2 Formulate the requirements which the solution must meet.

3 Examine available techniques and prospective difficulties.

4 Choose appropriate personnel.

5 Organize and prosecute design, experimental, and theoretical studies.

6 Surround designers and investigators with experts having knowledge in pertinent fields.

7 Stimulate personal processes through group impacts, and contacts on various levels of organization.

8 Weigh progress. Judge results. Reshape goals, as necessary.

9 Finalize with respect to detailed manufacturing, maintenance, installation, operating requirements.

Note that inductive thinking is involved in practically all steps.

These steps are fairly obvious, but to spell them out is to recognize the necessity and the power of group operation.

But groups are effective only in so far as they are integrated. A baseball team which has a collection of individual stars may not win. Team spirit is needed—and so it is in creative-engineering groups. This stresses the personal qualitities needed, the ways of mutual working, and the techniques of guiding (not bossing) the work of the group.

It has been said—and this warrants special emphasis—that in group effort it is quite as important how well people work together as it is what they know or what they can do.

INDIVIDUAL QUALITIES ESSENTIAL FOR GROUP OPERATION

Now I recognize that no man is such a paragon that he will possess in the highest degree all of the qualities desirable in group operation. But the compulsions and stimuli of the group are many, and one individual supplies what another lacks. Broadly, the following are necessary for this type of collaboration:

1 Humility and breadth to recognize the need of help from one's fellows in many specialized fields.

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[1] "Machine Design Management," by J. L. Alden, Trans. ASME, vol. 54, Paper No. MSP—54-9, 1932, pp. 105–115.

2 A broad understanding of the aims of one's associates, the types of techniques and problems involved, the types of knowledge necessary.

3 Group adaptability, which means pleasure in working together, eagerness to learn from others, tolerance of personal characteristics of others, stimulation of oneself through impact with others.

4 Intellectual honesty, which means a recognition that mistakes or omissions live on in the result (to be found by you or others, sooner or later, and corrected), and a resulting clarity of thinking and avoidance of rationalizing from false premises.

5 High standards of technical and economic performance.

6 Balanced judgment.

Parenthetically, it should be pointed out that groups are not wholly composed of engineers. The shop, installation, maintenance, and operating forces must be brought in as required, directly and indirectly.

Such groups, which, as I have said, are ever-changing and flexible, are a kind of society. They reach full effectiveness when members of the groups work intimately together—helpful, trusting, respectful, purposeful.

However, the key people in groups are of two kinds; the individual creators—designers and investigators—and what I shall call the synthesizers. The synthesizers are those who weld together the operations of the group. They are not necessarily individuals as such but a collection of portions of individuals. They may be in the higher echelons of organization—and because of experience, commonly are—but they may also be in the lower echelons.

Here let me say that in group operations, organizational rank as such must be used to guide and not to compel. A fact is a fact, whether it comes from a younger or an older man. Intellectual honesty and group enthusiasm requires deferring to facts and respecting the source of facts, whatever it may be.

The synthesizing is usually done by several of the leading engineers of a group. They assume this character wherever they have the ability to do so. It is they who envisage appropriate goals, who weigh the relative difficulties of achieving them, who criticize designs and experimental results in relation to the group objective, who criticize features and performance, and who generally shape the project in the way it should go. Typically, their work is based on a wide experience as to consumer requirements, a wide knowledge of things that work or have worked in the past, a sensitivity to things which cause trouble, a sense of proportioning, a sense of economics, and a high degree of impartiality of approach. They are the "judges." A good judge will supplement his intuition with an analysis of why he feels as he does.

Now it has not been my intention to paint a perfect society as present in every group. Men have their limitations, and a group has limitations in knowledge and ability. But recognition of the power and effectiveness of this type of working together, and recognition of the fundamentals and techniques for group success are indispensable to doing the best you can with the people and knowledge available.

CONCLUSION

To summarize, intuitive creative thinking in individual designers and investigators is a precious asset. There is a limited supply of it. Its effectiveness depends on motivation and scientific knowledge. Group operation, as opposed to more individual effort, can greatly increase its effectiveness. But group operation requires creative ability on the part of others in formulating, judging, stimulating, and steering group effort. Group operation also imposes special requirements on personal qualities, attitudes, and ways of mutual working.

"Automation"

(*Continued from page 390*)

the outside-diameter gages check size and taper. Groove widths and positions are checked in another station, as well as length and eccentricity between bore and the outside diameter.

Checking Castings Visually. While the system of automation provides for automatic loading into the machine and automatic tray loading from the machine, it has been found that this is a good spot to check these castings visually for casting pits, porosity, or blowholes. Imperfections occur occasionally in all sand-casting processes and, inasmuch as holes or pits are usually under the scale, they will not show up until after the metal-removing operations have been performed.

Under orthodox machine operations, which are handled manually, these faults in stock would be detected as the operations are performed. However, the few pieces which are to be discarded for lack of quality are easily spotted as they are hand-loaded in trays preparatory to plating.

Performance of Inspection Machine. This electronically and mechanically controlled inspection machine handles about 4000 bushings per hr, and gives the impression of an overactive beehive as the battery of solenoids and timing switches buzzes through their cyclized duties.

The sensitivity and accuracy of this machine were put through a severe test by injecting about 500 experimental bushings which had a special plate on the outside diameter which increased the bushing about 0.0002 in. dimensionally.

The inspection which was to have been a routine dimensional check, backfired when all 500 bushings were thrown out through the "oversize" chute before the remainder of the inspection could be performed.

While the bushings were made as intended for test purposes, the robot-type unit made no exceptions, and we were obliged to hand-check the lot. This was indeed a boost for automation because it proved that a mechanical brain does not deviate from a designed course.

The "reject" tubes from the machine lead to wooden boxes and as filled are carried away for correction or discard.

The "OK" tube directs the accepted bushing onto a cleated rubberized conveyer which would normally lead to further automatic loading of trays. However, we decided at this point to inspect the bushings visually and to hand-load them into trays. The heavy end of the bushing is up and each tray has 9 rows of 22 spaces.

Dipping and Coating Operations. These loaded trays are placed on racks of an automatic-dip-type phosphate-coating machine. Here the trays are dipped into various liquid compartments and travel in an oval course until they slide from the racks onto a chute which leads to an automatic roll-over table.

Moving Bushings to the Shipping Department. An empty tray designed so that the bottom will fit into another tray top, is placed over the loaded tray just emerging from the plating unit. The roll-over unit turns over 180 deg, emptying the bushings into this shipping tray. The shipping trays are made of sheet aluminum for lightness and for nonscratching qualities.

These trays are piled or stacked on pallets so the trays are 6 high—2 stacks end to end and 4 rows wide. Each tray holds 198 bushings and each pallet holds 48 trays. This makes a total of over 8500 bushings or nearly 2 hr production on each pallet.

The pallets are picked up by lift-type transporters, loaded onto a truck and sent to the engine-assembly lines. This operation completes what very nearly is a complete automatic operational function.

REMOTE ACTUATION *of* HIGH-PRESSURE VALVES

An Electrical Mechanism Developed for Remote-Control Purposes

By P. R. WEBER and J. C. CORBY, JR.

TECHNICAL SECTION, E. I. DU PONT DE NEMOURS & COMPANY, CHARLESTON, WEST VA. JUNIOR MEMBERS ASME

TO provide for the remote actuation of valves controlling the flow of fluids at pressures of 12,000 psi and over, it was desirable to develop a control mechanism which would give results approaching as closely as possible those obtainable with direct operation. The first proposal was to employ a pneumatic system which would feature a diaphragm-operated valve, but such a valve was not commercially available for the extreme pressures involved, and the cost of its development was considered excessive. Therefore, the decision was made to start with a standard hand-operated valve, known to be trouble-free at high pressures, and to develop an electrical mechanism for its remote actuation. The actuator which resulted has given highly satisfactory service and is the subject of this paper.

PRINCIPLE OF OPERATION

A wiring diagram, Fig. 1, and a view of the mechanism, Fig. 2, will be helpful in following the principle of operation. The high-pressure valve, item 6 in Fig. 2, is opened and closed by a geared electric motor of the reversible variable-speed type. The motor is equipped with a built-in gear reducer which furnishes low speed and high torque to overcome the opposing torque of the high-pressure-valve stem. The maximum stem torque of the valve used in the development is 33 lb-ft. In the connection between the gear-reducer output shaft and the valve stem is an adjustable slip clutch which limits the torque input to a safe value. In order to transmit the valve position a small Selsyn motor is geared to the valve stem. The Selsyn is hinged so that it can be lifted clear when clutch adjustment, setting of

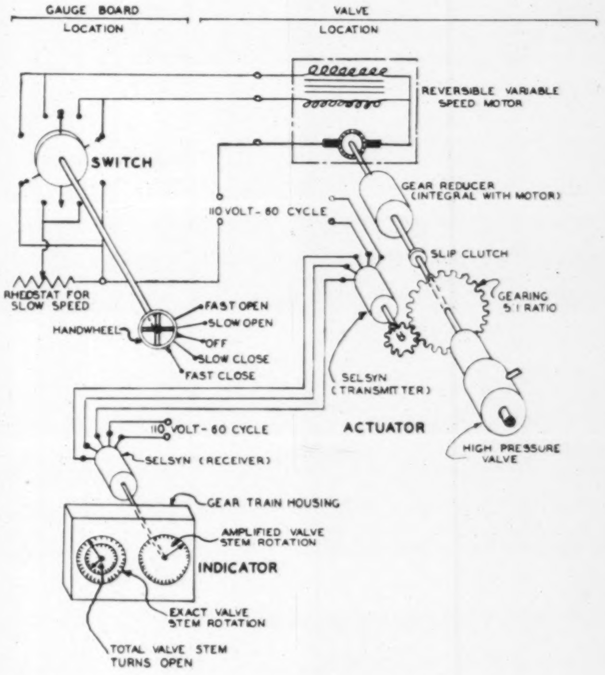
GAUGE BOARD
LOCATION
VALVE
LOCATION
REVERSIBLE VARIABLE SPEED MOTOR
SWITCH
GEAR REDUCER (INTEGRAL WITH MOTOR)
110 VOLT - 60 CYCLE
SLIP CLUTCH
RHEOSTAT FOR SLOW SPEED
GEARING 5:1 RATIO
FAST OPEN
SLOW OPEN
HANDWHEEL
OFF
SLOW CLOSE
FAST CLOSE
SELSYN (TRANSMITTER)
110 VOLT - 60 CYCLE
ACTUATOR
SELSYN (RECEIVER)
HIGH PRESSURE VALVE
GEAR TRAIN HOUSING
AMPLIFIED VALVE STEM ROTATION
INDICATOR
EXACT VALVE STEM ROTATION
TOTAL VALVE STEM TURNS OPEN

FIG. 1 WIRING DIAGRAM

1—Reversible variable-speed motor
2—Built-in gear reducer
3—Selsyn motor just above gear reducer and normally over slip clutch, item 4
4—Adjustable slip-clutch housing; drilled for inserting a bar when manual operation is necessary (drilled hole just visible above opening for clutch access)
5—Selsyn drive gear secured to valve stem
6—Valve

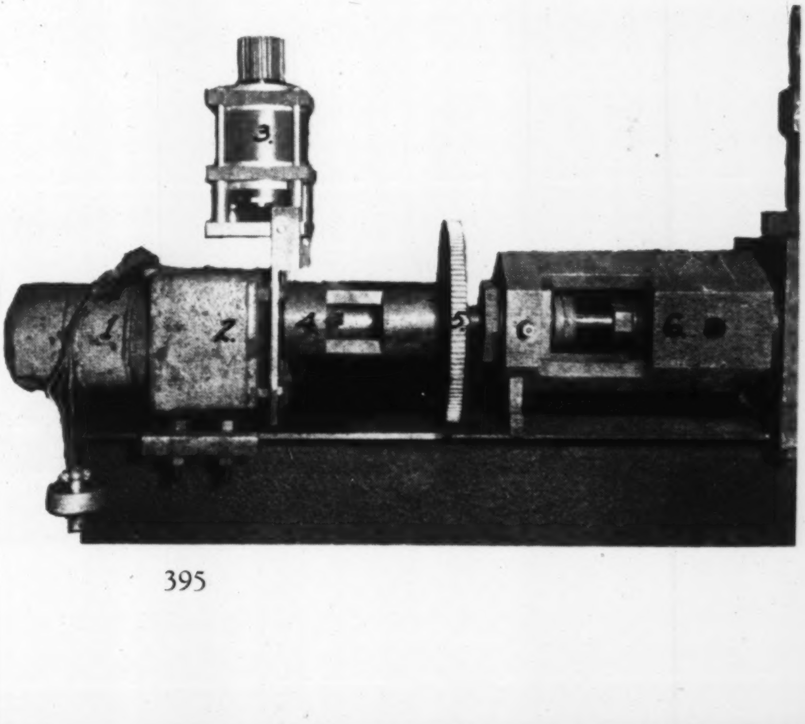

FIG. 2 ACTUATOR AND VALVE ASSEMBLY
(Showing Selsyn swung up in "out of the way" position.)

the position indicator, or manual operation is necessary. To operate the valve motor from the gage board, a single five-position switch is used. This switch, provided with a handwheel which resembles that of a valve, is spring-loaded to keep it normally in the central-off position. When turned to the left, the switch opens the valve, and, when turned to the right, it closes the valve. The first position to the left results in slow opening of the valve, and the second position results in faster opening. The first and second positions of the switch to the right give corresponding slow and fast closing of the valve. A rheostat is provided to reduce motor voltage for the slow speeds. This provision for slow speeds may not be necessary for many applications to which this actuator can be put. If it is not required, the switch need have only three positions instead of five.

The Selsyn motor geared to the valve stem rotates 5 times for every revolution of the stem. This arrangement amplifies the valve-stem movement to permit the indication of small changes in stem rotation. This transmitting Selsyn is electrically connected to an identical Selsyn coupled to an indicator at the gage board. The indicator, Fig. 3, is provided with two dials on which hands indicate the following:

Amplified Stem Rotation. On the right-hand dial, the hand makes 5 revolutions for each revolution of the valve stem. Each graduation represents 0.001 turn of the stem.

Exact Stem Rotation. On the left-hand dial, the long hand rotates at the same speed as the valve stem, and each graduation on the outer scale represents 0.01 turn of the stem.

Total Stem Rotation. On the left-hand dial, the short hand turns one tenth as fast as the valve stem and indicates on the inner scale the total number of turns of the stem.

ADVANTAGES OF SYSTEM

The remote actuation system covered in this paper is thought to have numerous features of merit, the more important of which are as follows:

1 It permits the high-pressure valve on which it is used to be reset exactly to its former position.

2 A valve position indicator shows how much valve trim wear has occurred at any time, assuming the valve is operating at constant-flow conditions.

3 The electric actuator, with the proper instruments, enables automatic pressure and flow control not previously possible because of former control-valve limitations.

4 It incorporates the following safety features:

(*a*) To prevent the breaking of valve stems by virtue of the slip clutch.

(*b*) To prevent the sudden opening or closing of the valve in case of a power failure, as compared to a pneumatic or hydraulic valve which either would open or close on failure of the actuating fluid pressure.

5 The actuator has demonstrated that it is dependable and capable of quick response, and that it will permit accurate adjustment of pressure and flow. The valve can be adjusted to within 0.001 of a stem revolution.

6 The actuator can be installed on standard high-pressure valves, thereby saving the cost of special valves.

7 A single handwheel is the only control required at the gage board.

8 In an emergency, it is possible to operate the valve directly.

EQUIPMENT SPECIFICATIONS

Specifications for various parts of the actuating equipment are shown in the following list:

Actuating motor:
Make, Link-Belt, type JD-1 (series wound with two fields, one for forward and one for reverse rotation)
Horsepower, $^{1}/_{6}$
Speed before reduction, 8000 rpm
Speed after reduction, 8.9 rpm
Gear ratio, 897.6 to 1
Voltage, 110 volt, 60 cycle, single phase
Current, 2.3 amp maximum
Slip clutch, spring-loaded adjustable type, furnished with motor
Cover, dust-tight galvanized cover over entire actuator unit
Switch:
Make, General Electric, type SB-1
Number of positions, five, spring-loaded to remain normally in center (off) position
Rheostat, Ohmite Model T, 100 ohm, Cat. No. 1314
Indicator:
Selsyn motor
  Make, Bendix autosyn
  Type, CAL-11277
  Voltage, 110 v, 60 cycle
  Selsyn speed to valve-stem gear ratio, 5:1
Dials (each indicator hand can be preset to any reading independently of the others)

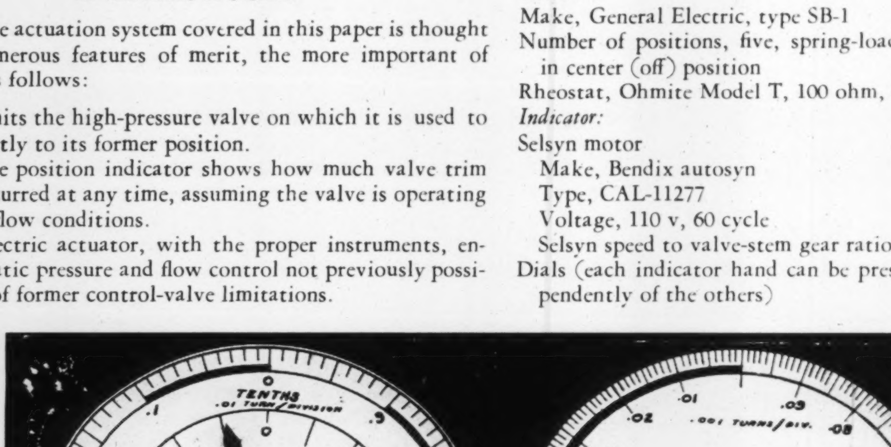

FIG. 3 INDICATOR FOR ELECTRICAL VALVE ACTUATOR
(Hands as shown indicate that the valve stem is 0.448 turns open.)

COLLEGE ANTECEDENTS *of Successful* ENGINEERS

By D. B. PRENTICE

FORMERLY PRESIDENT, ROSE POLYTECHNIC INSTITUTE, TERRE HAUTE, IND. FELLOW ASME

TEN years ago the second study of the college backgrounds of engineers listed in "Who's Who in Engineering" was published.[1] In that article comparisons were made with similar data compiled from the 1931 volume of "Who's Who," and surprisingly little variation appeared in the two lists.

Table 1 is presented giving a tabulation based upon the 16,000 biographies included in the 1948 edition of "Who's Who in Engineering," and again variations from the order of the previous lists are few. The table itself is self-explanatory but a restatement of the plan on which the statistics were compiled is in order. All three tabulations were made on exactly identical plans and therefore the figures are directly comparable.

Graduates of colleges in the United States and Canada, only, were considered, and bachelor degrees controlled the assignments of individuals to institutions. A graduate of a foreign technical school, for instance, who later received a master's or doctor's degree in this country was not listed. Graduates of arts colleges who later received bachelor degrees in engineering were credited to the engineering colleges. Graduates of arts colleges who later received master's or doctor's degrees in chemistry or geology, for instance, were credited to the institutions at which the first degrees were given. Graduates of engineering colleges who later received advanced engineering degrees were assigned to the colleges where the undergraduate studies were carried on.

An engineer was not assigned to a college unless his biography definitely recorded graduation, either by stating the degree received or the class in which the individual was graduated. For example, "M.E., Cornell," or "graduate, Cornell, 1910," would entitle a man to listing, but "studied engineering at Cornell" or "engineering student, Cornell," or similar inconclusive evidence of receiving a degree was not considered acceptable. From the 16,000 biographies, 12,964 clearly indicated bachelor degrees in engineering or science. This is a percentage of 81 compared to similar percentages of 76 and 82, respectively, for the 1931 and 1937 volumes of "Who's Who in Engineering." The earlier editions listed 11,400 and 12,000 biographies, respectively. The small change in percentage from 1937 to 1948, would indicate an interesting constancy in the proportion of American and Canadian graduate engineers who were trained on this continent.

The Massachusetts Institute of Technology again heads the list in total alumni included, with Cornell second. Alumni of these two private, or endowed, colleges furnish one eighth of all the engineers in the 1948 volume who were graduated from colleges in Canada and the United States. Thirty-five per cent of the 12,964 college alumni were graduated from the first ten colleges in the list, of which six are public and four private. This group totals 4525 of which 2374 are from public and 2151 from private institutions.

The first twenty-five schools provided 56 per cent of the

TABLE 1 COLLEGE ALUMNI LISTED IN "WHO'S WHO IN ENGINEERING"

	College	1948	1937	1931
1	Mass. Institute of Technology	933	761	664
2	Cornell	667	611	562
3	Michigan	585	460	385
4	Illinois	450	364	295
5	Purdue	384	309	254
6	Wisconsin	357	305	269
7	California	299	229	207
	Ohio State	299	254	192
9	Columbia	281	292	281
10	Yale	270	270	256
11	Minnesota	269	182	157
12	Harvard	234	200	190
13	Kansas	219	124	119
14	Pennsylvania	213	197	179
15	Iowa State	211	171	144
16	Rensselaer	194	125	120
17	Stanford	188	132	145
18	Penn State	181	147	110
19	Lehigh	174	175	201
20	Colorado	160	92	80
21	Washington	155	107	82
	Worcester	155	147	145
23	Stevens	150	122	122
24	Case	135	105	85
25	Nebraska	132	111	93
26	New York University	123	39	36
27	U. S. Naval Academy	120	64	56
28	Colorado School of Mines	119	76	82
29	Texas	113	62	42
30	Illinois Inst. of Technology	111	95	90
31	California Inst. of Technology	107	34	19
32	Missouri	105	92	82
	Tufts	105	54	39
34	Washington Univ. (St. Louis)	103	73	67
35	Princeton	102	68	68
36	Carnegie	101	51	35
37	Cincinnati	100	64	41
38	Maine	96	79	71
39	Missouri School of Mines	95	44	55
40	Iowa	93	56	43
	Michigan State	93	68	66
	Texas A&M	93	41	34
43	Johns Hopkins	91	53	38
44	U. S. Military Academy	89	78	92
45	Michigan School of Mines	87	100	96
46	Georgia Inst. of Technology	86	51	33
47	Kansas State	81	55	60
48	Syracuse	80	64	56
49	Brooklyn Polytechnic	74	45	38
50	Dartmouth	73	67	60
	Union	73	52	43
52	Kentucky	69	55	48
53	Rose	68	69	71
54	Toronto	67	36	28
55	Chicago	66	52	35
56	Cooper Union	65	51	41
57	Brown	62	61	48
58	Utah	58	40	30
	Virginia Polytechnic Inst.	58	37	37
60	Lafayette	57	49	40
	Rutgers	57	43	40
62	Pittsburgh	56	44	37

(*Table 1 continued on following page*)

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[1] "Alumni of the Engineering Colleges," by D. B. Prentice, MECHANICAL ENGINEERING, vol. 60, 1938, pp. 241–243.

TABLE 1 (*Continued*)

	College	1948	1937	1931
63	Oregon State	55	30	20
	N. Carolina State	55	22	18
65	C. C. N. Y.	52	37	28
66	North Carolina	51	25	23
67	Virginia	49	41	24
68	Oklahoma	47	27	27
	Tulane	47	42	34
70	West Virginia	46	33	33
71	Alabama Polytechnic	44	32	28
72	Drexel	43	8	4
	Vermont	43	33	28
74	Northeastern	41	8	3
75	McGill	39	27	35
76	Northwestern	37	24	15
77	Ohio Northern	34	39	31
	Tennessee	34	21	17
79	Alabama	32	15	5
	Bucknell	32	24	13
81	Swarthmore	31	27	22
82	Montana State	30	10	8
	North Dakota	30	19	15
84	Arkansas	29	25	24
	Idaho	29	19	12
86	Florida	28	9	10
87	Colorado State	27	22	19
	Mississippi State	27	18	16
89	Indiana	26	29	24
	Louisiana State	26	9	10
91	New Hampshire	25	22	13
92	South Dakota State	24	16	13
	Virginia Military Institute	24	25	23
94	Oklahoma A&M	23	19	12
	Rice	23	8	3
	Vanderbilt	23	15	17
97	Arizona	22	11	9
	Notre Dame	22	14	12
	Queens	22	11	17
	Rochester	22	16	15
101	Clemson	21	26	12
	Valparaiso	21	14	15
103	Denison	20	16	15
	Detroit	20	13	4
	Montana Mines	20	..	..
	Rhode Island State	20	13	12
	Tri-State	20	..	..
108	Colorado College	19	19	14
	Nevada	19	10	13
110	Clarkson	18	12	14
	Denver	18	..	..
	Newark	18	..	..
	Southern California	18	9	7
114	South Dakota Mines	17	15	11
	Washington and Lee	17	13	16
116	British Columbia	16	..	..
	Pratt	16	..	..
	Wesleyan	16	9	6
119	Marquette	15	14	12
120	Cornell College	13	11	16
	North Dakota State	13	8	3
	Trinity (Conn.)	13	12	8
	Williams	13	12	11
124	Colgate	12	10	9
	Haverford	12	12	8
	Maryland	12	..	..
	Oberlin	12	7	8
	Oregon	12	12	7
	Utah State	12	..	..
130	Catholic University	11	..	..
	Delaware	11	12	5
	New Mexico Mines	11	..	..
	Norwich	11	17	19
	Ohio Wesleyan	11	10	7
	South Carolina	11	9	6
	Wyoming	11	..	..
137	Amherst	10	10	14
	Carleton	10	..	..
	South Dakota	10	..	..
140	Franklin and Marshall	9	8	3
	Georgia	9	8	11
	Manitoba	9	..	..
	Ohio University	9	9	6
	Ripon	9	..	..
	Webb	9	7	..
146	Citadel	8	..	..
	Clark	8	..	..
	Depauw	8	..	..
	Highland Park	8	11	9
	Miami (Ohio)	8	..	..
151	Akron	7	..	..
	Dayton	7	..	..
	Gettysburg	7	..	..
	Grinnell	7	8	7
	Louisville	7	..	..
	Montana	7	..	..
	New Mexico	7	..	..
	Wooster	7	7	4
159–362	204 colleges with 6 or less			
	Total	449		
	Grand total	12964		

TABLE 2 DATA FOR SIMILAR COLLEGES.[a] PROPORTION OF LIVING ALUMNI LISTED IN "WHO'S WHO IN ENGINEERING"

	College	Living alumni	"Who's Who" listing	Per cent listed
1	Mass. Institute of Technology	22475[b]	933	4.15
2	Rose Polytechnic Institute	1716	68	3.96
3	Worcester Polytechnic Institute	4265	155	3.63
4	California Inst. of Technology	3195	107	3.35
5	Michigan College of Mines	2777	87	3.13
6	Stevens Institute of Technology	4800	150	3.12
7	Montana School of Mines	640	20	3.12
8	Missouri School of Mines	3285	95	2.89
9	Rensselaer Polytechnic Inst.	7000	194	2.77
10	New Mexico School of Mines	435	11	2.53
11	Case Institute of Technology	5480	135	2.46
12	Lehigh University	9210[c]	174	1.89
13	Carnegie Institute of Technology	6423[b]	101	1.57
14	South Dakota State School of Mines	1196	17	1.42
15	Alabama Polytechnic Institute	4000	44	1.10
16	Clarkson College of Technology	2357	18	0.76
17	Norwich University	1627[c]	11	0.68

[a] Figures not available for several other similar colleges.

[b] Total bachelor degrees conferred.

[c] Includes other alumni in addition to engineering.

total, with 3701 from 13 publicly and 3594 from 12 privately controlled institutions. The nearly equal division of responsibility for educating engineers between public and private schools is further emphasized when the totals for colleges having 100 or more alumni listed are examined. There are 18 public and 19 private schools meeting this condition, and they have 4258 and 4346 graduates listed, respectively. The total is 66.5 per cent of all the degree-holding engineers included in the volume. Thirty-seven institutions out of 362 which have one or more alumni included, or one tenth, furnished two thirds of all the graduates.

In spite of huge enrollments in many Midwestern and Western state institutions, New England colleges still train a very large proportion of successful technological practitioners. There are listed 2164 alumni from New England colleges or 17 per cent of the total, and other institutions east of the Hudson River increase the group to 2977 or 23 per cent.

It is not feasible to compare many institutions by the percentages of living alumni which are listed, although such a percentage is undoubtedly an acceptable measure of the success of the college. All graduates of Stevens Institute of Tech-

(*Continued on page 402*)

A Proposal for the IMPROVEMENT *of* TIME STUDY

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INTRODUCTION

IN this day and age, it is no longer necessary to develop the theme showing the necessity for production measurement. The need for accurate production measurement has been indicated time and again, so that the student of production management and the practitioner of its arts have come to rely upon it as one of the fundamental tools necessary for the planning, organization, and control of production. For those of us who have the time for theorizing, an interesting exercise would be to compare management's efficiency in discharging its production obligations with and without the use of production measurement.

Our interest is not merely in production measurement, but in accurate measurement at a reasonable cost. There is good reason to believe that the accuracy of production measurement is one of the directly related constants in the formula describing managerial efficiency. It is unnecessary at this juncture to rank in order of importance the tools which management must use to achieve a high degree of efficiency. Each has its part to play, and it is desirable that each reach a state of perfection.

Production measurement determines, by specified technique, the units of production to be forthcoming from a given piece of equipment or from a given worker. In most instances, the rate of production of the machine is under the control of the worker, so that in effect production measurement means labor measurement.

HISTORY OF LABOR MEASUREMENT

The history of accurate labor measurement dates from the first attempts at deliberate development and control of managerial efficiency. The attempt to establish accurate labor standards is now some 65 years old and stems from Frederick W. Taylor's work in attempting to secure complete control of the industrial operation. Time study was the technique established by Taylor for labor measurement with which he thought to determine what constituted a day's work or output, so that he could establish the necessary work loads for equipment and labor.

A definition of time study, most often heard, may be stated as the procedure for establishing the time required for the performance of a given task by an "average" or "normal" worker, under "average" or "normal" conditions of work, using specified (standard) methods, and specified (standard) tools, materials, and equipment. Taylor developed the technique to a point of utility consistent with either the contemporary state of knowledge or his own inclinations, and so left it to posterity. Posterity has been having a time with it since. Essentially, the technique consisted of dividing the job into small elements, recording the time required for the performance of these elements by means of a stop watch, and keeping a record of all events which transpired during the course of the study.

As we know, the results of the stop-watch time study were measures of the production of the operator observed and had to be converted into production rates applicable to all operators performing the task. The conversion was made by relating the production rate observed to an absolute yardstick, which is the production rate that could be expected of the "average" worker.

In the years since Taylor, improvements in the time-study technique have been aimed at refining the process of securing observed time values and at perfecting a means of converting the observed time values into "absolute time values" applicable to our so-called "average" employee working at a rate of speed reflecting "average" effort and under "average" conditions. More success has been attained in perfecting the techniques of securing observed data than in establishing a conversion factor, a natural result, since the latter problem is far more difficult.

Since the days of its development, the technique of time study has remained relatively unchanged, consisting now, as then, of the observation of an elemental breakdown of a job by means of a stop watch, the selection of a representative time value from the observations, and the use of correction coefficients to adjust the selected time to normal or base time. The advantages and weaknesses inherent in stop-watch time study as Taylor developed it, for the main part, still exist.

ANALYSIS OF TIME STUDY

Before making an analysis of the advantages and weaknesses of stop-watch time study, it might be well to say that this subject has been sorely belabored in recent years. It has become the fashion to view time study, its methods, and its practitioners critically. As a result, a number of articles have appeared on the subject. A sampling of the titles run as follows: "A Psychologist Looks at Time Study" (1),[1] "A Statistician Looks —" (2), "A Union Official Looks —" (3), "An Engineer Looks —" (4), and so on. It might be said that, following all this looking, time study still needs to be viewed critically. However, one might hope for criticism that is more definitive.

ADVANTAGES OF STOP-WATCH TIME STUDY

The advantages of stop-watch time study lie in what it aspires to do, and that is the establishment of production rates scientifically. The fact that a good deal of the methodology is pseudoscientific has been of small import when it is considered that the method of labor measurement has been taken out of the stage of estimating, based upon past production records, and advanced into that of firsthand observation and scrutiny. The results of the use of the technique have been tremendously rewarding, both in the establishment of production rates to meet various managerial needs, and in the accompanying job analyses which aid in making improvements in methods, layout, design, and tooling. In addition to measuring cycle time, the technique has provided a means of determining the extent and nature of noncyclical occurrences, such as would be caused by interferences and breakdowns, and provided some means

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[1] Numbers in parentheses refer to the Bibliography at the end of the paper.

for studying and roughly evaluating causes of work diminution during the working periods. Provision was also at hand for establishing data for standard elements applicable to many jobs.

DISADVANTAGES OF TIME STUDY

The defects inherent in stop-watch time study are serious from the technical viewpoint but not so serious as to warrant discontinuing the use of the technique, as sometimes advocated by some union officials. If other means were at hand for measuring the productivity of labor, then setting aside the technique until improvements could be perfected might be the proper course of action. As it is, the measurements provided by time study are so fundamental to production management that the withdrawal of the technique would impair managerial efficiency seriously.

In analyzing the defects of time study, it is well to remember that they have to be viewed in respect to time study as a system of measurement. An attempt to be definitive will be made, so as to indicate areas in need of development. The defects of stop-watch time study may be divided into four general classes, namely, (*a*) errors of sampling, (*b*) errors of definition, (*c*) errors of measurement, (*d*) limitations of usage. These defects may be viewed as criteria against which to measure the effectiveness, the reliability, and the validity of any system of time study or labor measurement.

Errors of Sampling. (*a*) *Meeting the prior requirements to sampling:* Presupposed to any observation or time study of a job are the following; the technique does not insure providing for these prerequisites:

1 That the "ideal method" under the circumstances has been developed and instituted as standard procedure.

2 That the worker has learned this method and has become skilled in its performance.

3 That the proper tools and materials are being supplied to the worker for the performance of the job.

4 That management has sufficient control of its operation to assure the worker that all factors beyond his immediate control are provided for. This implies that the tools and machines are operating at their best and will continue to do so, that materials are flowing to the worker free of defects or variations, and that surrounding conditions are being held reasonably constant.

(*b*) *Size of sample:* The size of sample to be taken has never been determined. Practically nothing has been done to determine the number of observations that would be required to arrive at a statistically conclusive sample. A method was once tentatively proposed (5) but nothing has been heard of it since. Perhaps with improvements and corrections of this method, it could be applicable to time study. The inability to produce statistically sound samples is intimately tied to the existing time-study procedure in which the observer's judgment must be relied upon for the selection and determination of the actual time value. Superimposing upon this situation the use of statistical methods and formulas would be a doubtful procedure for securing a higher degree of accuracy.

Errors of Definition: (*a*) The element as used in time study cannot be defined to give it universal coverage within its range of application. When an element is carefully defined, then its application is limited to the job at hand or to an identical job. If the element is more loosely described in an effort to achieve greater coverage, errors are incurred in its application from job to job.

(*b*) Such terms as average skill, average conditions, fully trained, etc., have not been defined adequately. It is only recently that the concept of supplying adequate definitions for method, under the procedure of standardized methods and tooling, has become widely accepted. The problems of determining at what stage a job has been fully learned, what constitutes sufficient skill at an operation, as well as what part of the method of operation is supplied by management and what part is brought by the worker through his skill and job knowledge, have not been delineated as yet. In general, it can be said that uniform definitions are lacking for the common terminology of time study.

Errors of Measurement. (*a*) *Errors in the use of the measuring instrument:* Although a good deal has been done to standardize the methods of reading the stop watch, little has been done to establish standardized limits of accuracy for readings of various durations. Without limits of accuracy, calculations of errors of observation are impossible.

(*b*) *Errors in selection of observed data:* A review of the literature indicates that some statistical techniques for measuring central tendency are in use. However, no attempt is made to inform the practitioner of the limitations, mathematical background, or statistical implications of these descriptive terms. Some sources advocate selection of data completely upon an opinion basis, under the name of "good" value.

(*c*) *Errors in the conversion of observed data into useful data:* As previously mentioned, the need exists to interject the observer's judgment between the selected observed time values and the final values which are to be used. The use of judgment is associated with the evaluation of a worker's performance against a preconceived "universal standard of performance." Many systems have been brought forth to provide for this operation or even to eliminate it. None of the existing systems of establishing correction coefficients to be applied to the observed time values can meet the following criteria of acceptance wholly and some not even in part:

1 That the time-study observer's evaluations are reliable, i.e., that he consistently will render the same evaluations for the same performance.

2 That different observers will render the same evaluations for a given observed performance.

3 That the universal standard of performance is valid, i.e., that it is related to some true base anchored on an evaluation of human capabilities and capacities.

4 That the universal standard of performance is applicable to all work and to all workers.

It does not require very much of an analysis to see that the various systems of establishing correction coefficients such as leveling (6), effort rating (7), or some of the older "mathematical systems, based upon minimum time, curves, etc., are specious indeed when required to meet the foregoing criteria. Of course, volumes have been written in favor of these systems by practitioners, whose sole claim made in their favor is, that "they work from the practical viewpoint and, incidentally, we have nothing better with which to replace them."

Limitations of Usage. Visualize the following situation which is by no means hypothetical, and in which the reader has undoubtedly found himself on numerous occasions. A new product is being introduced and various production-planning steps are instituted to transmute the product from blueprint to package. Machines and assembly stations are assigned loads, a tentative assignment; lines are organized and balanced, tentatively; and man power and tooling calculations are made, tentatively. Why all this tentativeness? Well, the product actually will have to go into production before time studies can be made and work loads carefully assigned, and stations and lines balanced; or should we say reassigned and rebalanced.

If the time-study technique could only provide standard time values prior to actual production, a tremendous saving could be achieved. If time standards were available prior to production, think of the effects it would have on allied phases of production management.

With accurately established production standards available for a new job, the operator, his trainer, and supervisor would have goals of achievement available from the first. As we know from psychologists, learning takes place more rapidly when definite goals are in sight for the learner. It also would be easier to avoid the formation of poor working habits which would require retraining or unlearning.

The entire process of production and methods of engineering would be increased in efficiency if time standards were available on a preproduction basis. Operation assignment and balancing could be accomplished from the first. Methods of development would be greatly simplified since the difference between methods, and the determination of savings in time and money, could be established accurately if time standards were available on a preproduction basis. Finally, the process of estimating would be changed from "guesstimating" to an accurate computation affair.

CURRENT IMPROVEMENTS

Turning to the brighter side of the situation, we find that all is not complacency among time-study theoreticians and practitioners. Self-criticism and soul searching are common, and if somewhat infrequently practiced, are compensated for by their intensity. If fault were to be found, it would be with the status-quo stand taken by some influential practitioners and consultants who could aid the course of research and development mightily by their patronage. Fault also could be found with the tinge of quackery and high-pressure salesmanship which still clings to some of the practitioners of the status-quo school, and to some of those who are capitalizing on innovations which, as yet, only hold out promise.

What is being done currently to improve time study? Attack on the problem of improvement is being made along three lines: (*a*) The effort-rating approach; (*b*) what can be called the mathematical-statistical approach; (*c*) The motion-element-standard-data approach, which for some incomprehensible reason is sometimes called synthetic-standard data.

Effort Rating. The most widely publicized approach is that of effort rating. Investigations on this technique are being sponsored currently by the Society for the Advancement of Management, in collaboration with participating industrial companies. According to published statements, the purposes of this research project are to develop and improve the technique of effort rating, and to reach some consensus of opinion on the question of "What constitutes a fair day's work," referred to here as the universal standard of performance.

Statistical Approach. Some little has been heard of the mathematical-statistical approach. An interesting work appeared recently (8) showing the application of statistical techniques to time study. This work is of definite aid and comes as a welcome addition, but it is only an aid and the basic problems, to some extent relieved, still remain (11).

Motion-Element-Standard Data. A remarkable amount of work has gone into the development of some individual motion-element-standard-data plans. This approach seeks to supply base (normal) time for all manual operations not controlled by any process requirements. It also furnishes the base time for the manual portion of any standard data to be developed. A trained analyst furnished with the system and the data, by observation of the operator at work, can determine the amount of base time for the job. The time standards provided in such a system are "standards of method" in that, careful determination of method must be made before base time can be established.

The approach, employed on several occasions by groups developing data under variations of this plan, has been to use laboratory methods of investigation plus detailed observation and measurement of shop operations for the purpose of standardizing body movements into larger but still fundamental elements. Countless thousands of observations were made of individual movements, of groups and patterns of movements, and of complete operations. Recourse was had to all sources that could have been of aid, such as, psychologists, physiologists, and others. Detailed studies were made of learning and other factory situations. Because the data developed were to be the basis for establishing base time for all manual operations in the plant, great care and detail were employed in their creation.

The results of individually undertaken developments have appeared in meager form in some publications (9), and textbooks (10). Some of the most interesting developments have never appeared in the literature, and knowledge of them is gained sub rosa or by hearsay. This situation may be attributed to the fact that the developmental work is being done by individual companies or consultants, who, for reasons best known to themselves, desire to withhold their work from public scrutiny. Because of the secrecy enveloping the systems recently developed, little can be told concerning whether or not the data set forth are established on a base reflecting the true capabilities and capacities of the industrial population, nor can it be ascertained whether or not the data were developed by scientifically approved methods involving proper sampling and controls.

In evaluating these approaches to improve time study, it is necessary to refer back to the criteria previously mentioned against which the effectiveness, reliability, and validity of any time-study system should be measured. These criteria cover sampling, definition of terms, methods of measurement, and limitations of usage.

COMPARISON OF PROPOSED IMPROVEMENTS AGAINST CRITERIA

Measuring the effort-rating system against these criteria, we find that the attack is being concentrated entirely on a phase of methods of measurement with the hope of establishing a universal correction coefficient or standard of performance. The results to be achieved along these lines are of a doubtful character (here the author knows that he is calling down the wrath of the gods), since its underlying premise rests on a nonfactual and unverifiable foundation. If anything, the approach will increase the reliability or consistency of an observer's ratings if not their validity or accuracy. As to improving the definition of terms, providing for adequate sampling, and removing the limitations of usage of time study, these appear to be beyond the limits of this approach.

The mathematical-statistical approach, which is slowly developing in its techniques, cannot satisfy fully the criteria established. The technique concentrates its efforts on sampling and some of the methods of measurement. The application of statistics to time study can provide only some of the answers to the problems in need of solution in the development of an effective labor-measuring technique. Whatever proved methods develop will be of aid not only in improving the existing technique but will be of aid in any research attempts which are undertaken.

The motion-time-standard-data approach appears to be the most fruitful in the possibilities presented. It will be well to remember that we are speaking of the structure and the theoretical foundation of the motion-time-standards-data system, not the numerical values appearing here and there. This approach satisfies a greater number of the criteria of acceptance than any existing or proposed system. In addition, it is the only system by which standard time can be established prior to production. One of F. W. Taylor's unrealized ambitions was to establish a dictionary of universal basic production standards, and this technique appears to be capable of supplying data of this sort.

A review of the known results of application of some existing systems indicates that they provide for accurate definition of terms and also a basis for accurate measurement. The need to convert observed time into normal or base time is, of course, eliminated, and reliability is provided in that one and many observers will arrive at the same answer repeatedly. Whether or not this answer, in terms of standard time, which constitutes the measurement of production, is a valid one, is another question.

Some contend that if the motion-time-standard-data approach is not to provide the one absolutely valid answer as to what constitutes a day's work, then it should be abandoned. With the contemporary state of knowledge in the impinging sciences of psychology, physiology, etc., being what it is this argument appears to be rather overdemanding. The important consideration is that because of the methods of assembling data for use under this system and the research methods that it employs generally, this technique will be the one capable of supplying the absolutely valid answer, when all of the necessary information is available. In the meantime, it can approach the answer most closely with the empirical means at its disposal.

CONCLUSION

By now, it should be clearly evident that this paper is an argument for the use of motion-time-standard data in the establishment of production standards. Some readers may be wondering at the paucity of results presented and at the apparent slighting of the few known existing systems. These are not oversights but are a purposeful part of the author's presentation. The development and adoption of this system holds forth the opportunity for making the greatest forward stride in the advancement of time study.

As previously mentioned, the past few years have seen some work done privately in developing data under some variation of a system of this sort. Because of the intense demand for some improvement of time study, these data are finding their way into the hands of many practitioners by way of articles in the technical press and information in some textbooks. This dissemination of unsupported data will cause more harm than good, since the use of the data generally requires intensive training, and especially since the data have not been verified. A classic example is to be had in a very recent text which presents data of this sort to be used not for the establishment of standards but for rating. The author involved gives no description of the methods to be used in making analyses with these data, nor does he give any supporting evidence. To top this off he puts the data to a perverted use, rating, wherein it will be impossible to verify the validity of either the data or the ratings.

The course of action awaiting forward-looking engineers is one of nonsecretive co-operative research and development of data under this system for the use of all. The method of approach suggested is the formation of a committee representing practicing professional and research engineers for the purpose of securing available data, and examination and evaluation of such data. Following this exploratory stage, a research project should be established as a joint enterprise between engineering professional groups, industries, and educational institutions for development of a valid system. Such a research project is no mean undertaking, for it will involve considerable laboratory work and industrial trial and development. The efforts of engineers, psychologists, physiologists, and others will be required and, as with all basic research, it is felt that educational institutions and their laboratories and scientists would be of great importance in developing the fundamental and theoretical structure. The final development and application procedure could best be perfected by industry. This course of action to develop a system of motion-time standards will not supply the answer immediately but, within a few years a useful, reliable, and valid technique will be available to the profession.

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College Antecedents, Successful Engineers

(*Continued from page 398*)

nology are possibilities for inclusion in "Who's Who in Engineering," but many graduates of Princeton obviously are not. Ratios based upon total living graduates of these types of institutions evidently are not comparable.

Table 2 includes percentages calculated for institutions which are similar and for which the ratios are significant. The author is indebted to the registrars or alumni secretaries of these colleges for the graduate figures.

It seems unnecessary to comment on the figures disclosed in Table 1. In general, colleges which have good reputations in the engineering world stand this test well. In proportion to size their totals are in the upper part of the list.

The totals of institutions such as the University of Chicago, which have no engineering schools, are surprising. Alumni of these colleges secure listing in an engineering volume usually through work based on physics, chemistry, or geology. Comparisons between institutions based on age or geographical location are interesting but not particularly revealing.

In conclusion it should be pointed out that colleges whose enrollments have been restricted lose position in the list without losing in absolute totals, even though their standards have not changed. The rapid and unrestricted growth of certain well-known engineering colleges has almost automatically, through the years, expanded their groups of "Who's Who" alumni. The majority of alumni listed in the 1948 volume received their degrees between 1910 and 1930.

GRADUATE ENGINEERS *in the* FIELD *of* DESIGN

Industry Aids the Colleges in Preparing Specifications for Tomorrow's Engineers

By JAMES B. HARTMAN

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In order to plan effective curricula for preparing mechanical-engineering students for careers in design, the help of industry has been enlisted in developing specifications for such training of engineers. To this end a survey of a hundred industrial organizations in twenty-three states was carried out in recent months, which sought answers to such questions as the following: What personal characteristics and what special features of training are needed? How widespread is the demand for such graduates? Is a definite training program established for such men in industry? Are qualified graduates interested in design careers? How does our graduate compare with the European graduate engineer? In addition to these broad questions, certain pertinent details of our present curricula need to be viewed critically.

METHOD OF MAKING SURVEY

The questionnaire method of conducting the survey was adopted, care being taken to avoid the "leading" variety of question, and to assure that a true cross section of the field of interest was covered. Local situations were eliminated, and every effort was made to insure the widest possible diversity of coverage.

All important industrial centers throughout the country were canvassed, consideration being given to as many as possible of the outlets in industry for the talents of mechanical engineers in the field of design. These included large and small plants engaged in various types of manufacture, such as mass-production parts, special designs of heavy machinery, built-to-order high-precision work, assembly work, and so forth.

A list of pertinent questions was prepared and distributed to manufacturers, public utilities, consulting engineers, chemical and metallurgical plants, and the like. The individuals addressed included chief engineers, chief designers, vice-presidents in charge of engineering, and many others. In large companies separate replies were sought and received from plants in different locations. Data were also obtained from representatives of the personnel departments specializing in hiring technical personnel or in their training.

The responses to the questionnaires were extremely gratifying, replies going far beyond the limits of the questions asked. Many of the replies represented a summary of results based upon independent surveys undertaken by the parties originally addressed, in various divisions of their own organizations. It was generally apparent that the hiring and training of mechanical engineers for design work was of vital concern, presenting many opportunities for basic improvement.

THE TYPE OF MAN INDUSTRY SEEKS

Six personal characteristics were stressed as being desirable in a designer: (*a*) Ability to co-operate with others; (*b*) initiative; (*c*) imagination; (*d*) neatness; (*e*) accuracy; and (*f*) analytical ability.

Among the desirable special features in training and education of the industrial engineers should be mentioned the following:

(*a*) A good foundation in the fundamental sciences.
(*b*) Mathematical ability.
(*c*) Drafting ability.
(*d*) Knowledge of shop practice.
(*e*) Ability to write and speak clearly and forcibly.
(*f*) Knowledge of materials.

INDUSTRY'S PART IN TRAINING DESIGNERS

Seventy per cent of the industries surveyed hire graduate mechanical engineers for a specific assignment to design work. An additional few indicate that they wish to obtain such men but in recent years have been unable to find them.

While only 49.5 per cent follow a specific training procedure with young designers, several replies emphasized industry's needs for further planning in this direction.

In a number of instances it was stated specifically that industry's part in the training program should begin before graduation. A few indicated a definite preference for co-operative education.

One large manufacturer of heavy machinery described a program of employing sophomores and juniors for summer work. These men were carefully screened and chosen because of their interest or past experience in machine design. The summer is spent working for a senior designer and the work is supplemented with weekly discussion groups. This affords the company an opportunity to screen the men, and it gives the men an opportunity to decide whether they wish to continue with their studies in this direction.

ATTITUDE OF THE GRADUATE ENGINEER TOWARD DESIGN

While no part of the questionnaire was specifically directed toward an appraisal of the graduate's attitude toward design, unsolicited comments referred to the reluctance toward undertaking careers in design. Since then, these observations have been supported by discussions with technical personnel supervisors in industry and directors of placement bureaus in leading technical colleges.

The reluctance on the part of graduate engineers toward entering the field of design seems to be related closely to a dislike of drawing work. Even students of demonstrated aptitude and professed interest in the field are inclined to avoid oppor-

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Contributed by the Machine Design Division for presentation at the Spring Meeting, New London, Conn., May 2-4, 1949, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

tunities for employment where definite mention is made of an assignment to the drafting room for a training period. One of the purposes of this paper was to obtain data on industry's current practices with designers. The importance of ability and training in drafting needed to be ascertained directly from industry.

The Alumni Placement Office of the Massachusetts Institute of Technology states: "The average junior engineer has an absolute horror of getting stuck on the drafting board. The large engineering firms where a year or so at straight drafting is considered a necessary part of a young man's training are being avoided by a great majority of our graduates. A mechanical engineer seems to have no objection to being called a junior design engineer and doing drafting perhaps two thirds of the time if he feels that at least he is engineering and, to his way of thinking, working his way away from the board from the time he goes into a company."

The graduate placement officer at Drexel Institute of Technology states, "there is in general a dislike for continuous work on the drawing board."

The chief engineer of a large gear manufacturer observes, "the real trouble is that the real bright boys find better paying employment in other lines . . . ."

The present survey provides some basis for further consideration of these points.

DRAFTING ABILITY

Drafting ability in the prospective employee is sought by 79 per cent of the replies to the questionnaires. Furthermore, the men who are hired spend, on the average, 65 per cent of their time on the drawing board for the first year. This percentage of time decreases to about 30 per cent in the third year. The drawing-room work is viewed (and rightly so) as a vital part of the training, along with shopwork. Granting without question that this experience is necessary to the designer, means of improving the situation need to be considered. To this end, the following suggestions are offered:

1 Realizing the importance of first impressions, the methods followed by the colleges in presenting the first courses in "engineering drawing" should be examined critically. Emphasis needs to be placed on providing the engineer with a means of expressing his ideas graphically, encouraging his originality and ingenuity, and eliminating copybook exercises and drudgery. Here the responsibility is that of the college.

2 The students should be encouraged constantly to illustrate their thoughts and explanations with sketches. All problem work should be accompanied by sketches. Freehand sketching ability is one of the designer's greatest assets. Here again the responsibility belongs to the college.

3 In hiring graduate engineers for design, industry should use a tactful approach. Emphasis should be on the opportunity for individual creative work. In the case of a man who has promise, regardless of his lack of experience, he should be given an original project, however simple. Call him a "project engineer." Let him develop something original. If he is responsible for it he will be only too happy to put it on paper. Increase the difficulty of his projects and he should develop with them. Too little thought is given to the training program. Show him what his opportunities are; avoid drudgery. Let him feel that his tasks are such that they require a college education, and not simply high-school training. Here the responsibility is industry's.

4 It is the responsibility of experienced engineers and the professional societies such as the Machine Design Division of this Society to acquaint students with the rewards and satisfactions of work in the field of machine design. The erroneous impressions regarding life at a drafting board must be removed. A committee of this Society, headed by B. P. Graves, has been set up to provide speakers to student branches, who will present a true conception of the field, its requirements, and awards. This program holds great promise. Certainly there is an attitude toward design which calls for correction, and it is vitally important that this be done. The dependence of our industrial life upon design is known to all of us.

U. S. TRAINED DESIGNER VERSUS EUROPEAN

It is well known that many key positions in the field of design in this country are held by engineers with European training. Approximately 54 per cent of those who responded to the questionnaire felt qualified to compare engineers trained in the United States and those with European training. Fifty-six per cent of these believed the European engineers to be superior.

IMPROVEMENT OF THE CURRICULUM

A major proportion of the questions were directed toward a critical examination of certain common features of the typical mechanical-engineering curriculum particularly affecting the future designer. These will be discussed individually, not in their technical details but in terms of broad basic considerations.

Statics, Dynamics, and Strength of Materials. At least 78 per cent of those responding to the questionnaire considered training in statics and dynamics adequate, while 73 per cent considered the strength-of-materials courses also to be adequate. These courses generally are understood to be prerequisite to work in machine design. It would be interesting to know what the professors of machine design would have to say about their students' knowledge of these courses prior to beginning their work in design. Instructors in these subjects constantly tell of the time they are forced to spend teaching mechanics. Possibly this repetition goes part of the way toward providing a suitable foundation. It is highly desirable that the problem work in later design courses be planned to utilize and emphasize the principles taught in the basic mechanics.

Mathematics. Preparation in mathematics was declared adequate by 82 per cent. The author is inclined to agree that, in all likelihood, the mechanical-engineering student is exposed to sufficient mathematics. He doubts, however, that a sufficient number of students recognize and utilize the full value of the tools which mathematics furnishes them. It would be interesting to know how many engineers pick up a technical article, attracted by the title pertaining to their field, only to be forced to put it down because of the mathematical nature of the contents. The ASME *Journal of Applied Mechanics* illustrates the point. It is the author's opinion that extensive fundamental work given in the mathematics department loses its value if subsequent engineering courses do not apply the principles of mathematics. The mathematics department is a service department to our engineering courses. The engineering department should be aware of the details of the work being taught in mathematics and should encourage the student to utilize this powerful tool—not avoid it.

Metallurgy. Preparation of graduate mechanical engineers in metallurgy was declared unsatisfactory by 70 per cent. Since metallurgy is a service course, it is quite possible that in many instances the course material is taken for granted by the mechanical engineers without careful scrutiny of the actual content and its ultimate usefulness. The metallurgist is interested in the preparation of the metal from the raw materials and its further processing to obtain specific properties. The mechanical engineer is concerned primarily with properties of metals. Close co-operation should exist between these departments to assure complete understanding of the needs.

Advanced Dynamics. Seventy-two per cent declared mechanical engineers insufficiently prepared in advanced dynamics, including vibration theory, balancing, and kindred subjects. Mathematical ability is desirable in these courses. In some instances this material is covered in elective courses.

Shop Courses. The so-called shop courses are favored in the following order of importance: (1) Machine shop, (2) foundry, (3) welding, (4) forge shop, (5) woodworking.

Among the comments submitted, many definitely favored these courses, but with emphasis on teaching the possibilities and limitations of various techniques, rather than the acquisition of skill in their use. No decision was reached as to the desirability of including shop courses at the expense of basic courses, such as mathematics, mechanics, metallurgy, humanistics, and the like; the vote was split equally.

Summer Industrial Employment. By 76 per cent, the opinion was expressed that summer employment in industry could take the place of shop courses. In the opinion of the author, summer employment must be planned and regulated carefully if it is intended to displace shop courses in the curriculum. If this cannot be done, the summer work must be supplemented by some course work in shop theory or in industrial processes.

Machine Design. The questionnaire developed certain facts concerning the courses in machine design. Fifty-eight per cent felt that present graduates were trained insufficiently in the design of machine elements; 59 per cent felt that courses should go beyond elements through the design of a complete machine, with a 63-37 per cent split between calculations and drawing work, with emphasis favoring calculations.

MACHINE-DESIGN TRAINING

Machine-design courses serve important functions in the mechanical-engineering curriculum. They form a part of the broad foundation upon which any mechanical-engineering career is built. Here at last are assembled and applied many of the early lessons in mathematics, physics, statics, dynamics, metallurgy, strength of materials, and other fundamental courses, which, at the time they were studied, included material that may have appeared to be largely of academic interest. Here also are provided opportunities to develop and exercise originality and judgment, i. e., engineering judgment.

Regardless of his ultimate place in the industrial picture, it behooves a man to become acquainted with the possibilities and limitations of basic mechanisms and machine elements. Those who will not enter the field of design should be restricted to the fundamentals in their machine-design courses. Their study of design analysis should be concentrated upon machine elements. Time will not permit them to design complete machines.

For those who plan a career in design, additional material should be available either in the form of electives or as prescribed courses in a design option, if the option system prevails. In order to provide even a minimum of training, the basic courses in mechanisms and machine elements should be followed by an advanced course in machine design in which the previous courses are consolidated and extended through the design of a complete assembly of elements. Projects should be chosen not for their complexity but for purposes of illustrating the interdependence of individual elements.

A senior elective course should be offered in "stress analysis for machine design." In this course, the limitations of theoretical stress analysis are recognized and the powerful tools provided by experimental stress analysis are introduced and utilized. Residual stresses, fatigue, stress concentrations, and kindred subjects should be considered in detail. This course would supply a definite need in providing means for attacking new problems, beyond the scope of the conventional texts with their emphasis upon codes, catalog data, and the like.

CONCLUSION

It is the author's opinion, supported by this survey, that irrespective of the future field of employment, emphasis, in the four-year undergraduate program, must be on a firm grounding in fundamental principles. Promising men should be encouraged to do their specializing in graduate work.

Mackintosh-Hemphill Co.

TURNING ONE HALF OF A CRANKSHAFT FOR A 10-CYLINDER 7100-HP DIESEL ENGINE AT NORDBERG MANUFACTURING COMPANY, MILWAUKEE, WIS. THE 5-THROW SECTION SHOWN IS ABOUT $23^{1}/_{2}$ FT LONG AND WEIGHS ABOUT 22 TONS. THE 84-IN. × 50 FT LATHE IS DRIVEN BY A 75-HP MOTOR

HUMAN ASPECTS *of* ENGINEERING

By THEODORE F. HATCH

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ENGINEERING is commonly defined as "the art and science by which the properties of matter and the sources of power in Nature are made useful to man, in structures, machines, and manufactured products." Engineers are practitioners, who develop from the basic laws of science practical rules of engineering analysis and design which permit them to create, with a high degree of certainty as to results, new structures, machines, and manufactured products having pre-established properties and functions. Within this limited definition, the engineer's first responsibility is to the laws of science, which he must obey unfailingly to insure certainty of results. In so far as responsibility to the public is concerned, the definition requires only that his creations be useful. It is recognized, of course, that public structures, such as buildings, dams, bridges, and the like, must be structurally safe, and that the laws for fire protection, water sanitation, industrial safety, etc., designed to safeguard the health and safety of the public, must be observed. The engineer is required, however, only to make proper use of sound accepted principles of engineering design and otherwise follow the requirements of codes and other regulations. He is not responsible for failures which occur because of inadequate laws.

Engineers recognize and accept these responsibilities so fully that they require no elaboration here. To be useful, this discussion must concern itself with broader responsibilities which, at the present time, are not so widely recognized and accepted.

A PHILOSOPHICAL DEFINITION OF ENGINEERING

A more significant definition of engineering, and in a sense the official definition of the profession, is as follows: "The art of organizing and directing men and of controlling forces and materials of nature for the benefit of the human race." Whereas the first definition limits the engineer's job to affairs of the physical world, this one recognizes his concern also with human problems for which, however, he finds no ready guide in the laws of physical science. Further, it requires that the structures and machines which he creates must be beneficial to the human race and not just useful to man. The implication here is much broader since a useful object is not necessarily of benefit to all mankind. Practical usefulness is established if an object has sufficiently wide acceptance to justify its production. The demonstration of real benefit to society, however, is much more complex, requiring a more refined yardstick than sales records.

In the larger sense of this broad definition, there is considerable dissatisfaction at the present time with the role of the engineer in society, which is voiced not only by sociologists and other students of human affairs, but also by leading engineers, as evidenced by the criticism which regularly appears in current engineering journals. In a word, the engineer is criticized for being too narrow in his interests, for limiting his responsibility to the functional design of machines and structures, and leaving to others all concern for their impact upon society. He has fulfilled his responsibility when a new machine, for example, turns out more units of production at less cost, without regard to the social and economic problems which may be created by such mechanization. This attitude, the argument continues, springs from the widespread acceptance of the view that there is self-evident good in all technological advances which result in greater productive capacity. Secure in this belief, the engineer has not worried about temporary ill effects which are assumed to be more than offset by the total gain. At the Princeton Conference on Engineering and Human Affairs in 1946, Merton[1] enlarged upon some of the undesirable consequences of technological advances and presented three reasons to explain the engineer's lack of concern with them:

1 Extreme specialization in the engineering profession, requiring the services of several different kinds of engineers to complete a particular development. Because of his well-defined and limited contribution, it is easy for the individual specialist, in such cases, to divorce himself from the social consequences of the finished structure.

2 Professional codes of ethics, which limit responsibilities to technical matters and discourage the engineer from venturing into "social" science.

3 The general employment of engineers in large organizations in which they take their place as experts in a subaltern role with fixed and limited responsibilities. In this status, they are rewarded for viewing themselves as technical auxiliaries.

ENGINEERING VIEWED BY THE PHYSICAL SCIENTIST

From the physical scientist's point of view, Mills has expressed somewhat the same ideas in a book,[2] published in 1946. Several quotations from the introduction are pertinent.

He writes (p. xiv): "The social effectiveness of the engineer is today almost entirely indirect. He develops, in general, what his employer wants, whether that employer is a government or a private corporation. He has little concern whether his products are utilized for general welfare or for violent destruction." And again (p. xvii): "The problems which he must help society to solve are those of human relations, social, economic, and political. These he must approach in the same way as he does those of engineering. That means he must apply to them the scientific method, discarding the prejudices of his early environment and avoiding the fallacies of his general education." Further: "If the engineer is to be effective in social contribution, beyond the physical instrumentalities he makes available, he must arrive at his conclusion in an engineering atmosphere, one in which the problem is objectively considered with like-minded colleagues."

THE ENGINEER'S DEFENSE

These are broad points of criticism, wholly objective in nature, and, as such, they must receive earnest consideration and thought by engineers. The present author is not competent to elaborate upon them nor argue against them. In

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Presented before a meeting of the Pittsburgh Section, Pittsburgh, Pa., December 6, 1948, of The American Society of Mechanical Engineers.

[1] "The Machine, the Worker and the Engineer," by R. K. Merton, *Science*, vol. 105, 1947, p. 79.

[2] "The Engineer in Society," by John Mills, D Van Nostrand Company, Inc., New York, N. Y., 1946

defense of the engineer, however, it can be said that he has done no more than share with American society as a whole his belief in the inherent goodness of technological advances. Indeed, no one suggests that we should stop or even slow down our technical progress, only that we give more attention than in the past to its total effect upon society. To quote from Merton again: "To the extent that social scientists have failed to address themselves to this problem, there is no informed basis for the most socially oriented of technologists to act with due social responsibility."

Favorable, also, to the engineer is the need voiced by many social scientists for his point of view and systematic approach in the study of the problems of society. The engineer's insistence upon demonstrated quantitative relationships and specific laws, rather than upon broad general statements, as a basis for conclusions and action is required, it is claimed, to complement the skills of social scientists in the further advance of this field. These very attributes, however, lead the engineer to avoid such problems, because he is not convinced that they are capable of engineering analysis. When he does concern himself with social problems, he is apt to do so, not as an engineer, but as a general member of society.

Even in scientific management, a recognized branch of engineering, the problems of human relations are largely dealt with as matters outside of the technical field. In this point of view, the engineer is certainly encouraged by many physicians, physiologists, and even psychologists who emphasize the variability of man and shy away from quantitative descriptions of his behavior patterns and of his reactions to environmental stress.

A point to be emphasized, therefore, is this: If the responsibilities of the engineer are to be broadened to include appraisal and control of the human and social consequences of his technical efforts, then it must be demonstrated that these responsibilities can be assumed without departing from the fundamental concepts and approach of engineering. Indeed, one must take issue with the argument that the professional engineering code is at fault. It is the very devotion of the engineer to facts and to the laws of science which has made possible the technological advances we do enjoy, whatever may be their undesirable consequences, or their improper use. Nothing would be gained if, in broadening his social interest, the engineer lessened his critical and objective point of view, for we would then have poorer engineering and no real contribution to social science. On the other hand, if it can be shown that these problems, to whatever extent, are capable of engineering analysis and that the engineer can aid materially in their solution, then one can have no doubt of his acceptance of the greater professional responsibility.

"HUMAN ENGINEERING"

What is needed is an accepted field of engineering activity which may be called, for lack of a better term, "human engineering." Contrary to the popular definition, Mead[3] has defined human engineering as "engineering design in relation to man's anatomical, physiological, and psychological capabilities and limitations." Implicit in this definition is the idea that man's capabilities and limitations can be described in useful engineering terms, thus making it possible to draw upon them along with physical technology in engineering design, and so make more certain, in advance, of a satisfactory relationship between man and the machine or structure under consideration

Much work has to be done before this broadening field of engineering is developed in full measure. Co-ordinated research is required, involving teamwork between engineers, physicians, physiologists, psychologists, and others in the study of the complex problems of society which are beyond solution by individuals. In such co-operation, as Mills points out, scientists and engineers are particularly well schooled.

It is not necessary, however, to wait upon long-term research, before introducing these ideas into engineering thinking and practice. Indeed, many engineers have already broadened their thinking and work in this direction. For example, in ventilation and air conditioning, illumination, water purification and sewage disposal, control of toxic chemicals in industry, etc., man's characteristics of response to environmental forces provide much of the basis for engineering design. It can be said, nevertheless, that engineers as a group are not taking full advantage of the known and meaningful relationships which do exist nor of the experimental techniques and assistance of physiologists, psychologists, and others in the analysis of their problems. They are largely content to receive information secondhand and to regard it as coming from outside the province of engineering. They remain primarily interested in functional design and feel that these matters are secondary.

PHYSIOLOGY AND PSYCHOLOGY NATURAL FIELDS FOR ENGINEERS

There are many opportunities for effective work by engineers in applied physiology and psychology. An eminent teacher of physiology once said he could give to engineers a much better course in physiology than to others because they found in this subject so many principles of engineering design and other familiar landmarks. After all, the human respiratory system is a gas-liquid equilibrator of superior chemical-engineering design! The contributions of engineers to our present understanding of thermal physiology have been outstanding, as attested by the work of the ASHVE Research Laboratory. Much of the recent work in design of cold-weather clothing has its basis in physics and engineering. Industrial toxicology provides a great volume of specific and quantitative data on the reaction of man to a host of chemical and physical agents encountered in industry Much of the information is in the form of equations, graphs, and tables, with which the engineer should feel quite at home.

For example, the behavior of dust in the respiratory tract, the rate of absorption of vapor and gases from the lungs into the blood, relationship between barometric pressure and rate of solution and elimination of nitrogen from body tissue, and others, are considered in fairly refined mathematical terms.

Similar examples are found in psychological problems. In the design of machine controls, as to location, sequence of operations, and optimum shape of handles, levers, and push-buttons, the engineer will find much systematic work of immediate use. Advances in the design of instrument dials, in relation to readability, order of presentation, reduction of error, etc., have great practical value in quality control and lessening of wastage in industry. Those who have followed the development of servomechanisms, need no reminder of the problems posed in relating characteristics of machine response to human control.

Mechanization has gone on in industry for many years with little thought given to the human operator. With the increasing complexity of automatic machines, however, the man-machine relationship may break down seriously unless engineers master the laws of physiology and psychology which determine human capabilities and limitations and utilize them in their designs. Similarly, in respect to the variety of artificial controls which are being applied in ever-increasing extent to the human environment, there is need for more complete understanding and use of these laws in design.

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[3] "Machines Tailored to Man Kindle New Engineering Design Concepts," by L. C. Mead, SAE Journal, vol. 55, Dec., 1947, pp. 40–46.

The few examples given here serve only to suggest the manifold opportunities for the engineer to broaden his horizons without weakening his engineering base. The many instances during the war of improvement in the design of military equipment from the standpoint of the operator, constitute striking evidence of great accomplishments which are to be had from the joint efforts of engineers, physiologists, and psychologists.

A PRACTICAL TECHNICAL SCHOOL PROBLEM

Expanding the scope of engineering starts of course in the technical schools. Efforts in this direction, however, through the addition to the engineering curriculum of psychology, sociology, modern history, and other courses from the liberal arts, have not been wholly successful. Dissatisfaction is expressed by engineering instructors as well as students. Both begrudge the time taken from meaningful technical matters and devoted to such unrelated subjects having no apparent value to the engineer.

The author would suggest certain reasons for the lack of complete success in these efforts: (1) The courses are rarely planned with the particular interests and needs of engineering students in mind. (2) The instructors are usually not acquainted with nor especially interested in engineering. They can scarcely be expected, then, to make any great effort in the development of relationship between their own subjects and engineering problems, much less to reduce them to the quantitative terms of engineering. Further, they do not find a very receptive audience since, along with their primary interest in the practical aspects of applied science, a large percentage of engineering students have an instinctive disinterest in the arts.

The correction seems obvious: The objective of the program should be to broaden engineering rather than to "liberalize" the engineer. Thus it should be set up as a major departmental activity in the engineering school, headed by an engineer who has a particular interest in human problems and training, and experience in one or another aspect of human engineering. He will plan the courses in relation to engineering needs, enlist the aid of specialists from other departments to supplement his own with their detailed knowledge and will relate their separate contribution to the whole program. Especially, will he develop for the engineering students the extent to which the various human relationships can be reduced to quantitative terms for use in engineering design. Until the program is thus given an important position in the engineering school, efforts to liberalize the curriculum will not be fully successful, and the responsibilities of future engineers will continue to be centered in functional design, with the related human problems remaining in a secondary position.[4]

CONCLUSION

The social effectiveness and responsibilities of the engineer are questioned by sociologists and in current engineering literature as well. The argument is advanced that engineers are too devoted to the physical sciences, leaving to others all concern for the impact upon society of the machines, structures and products which they create. The social consequences of technology must receive more objective and critical analysis by engineers than in the past. To bring this about, however, the scope and responsibility of engineering must be broadened to the extent that the social and human problems can be defined in quantitative terms and dealt with in the ways of the engineer.

Many opportunities exist for effective engineering interest and activity in the fields of applied physiology and psychology which justify the acceptance at this time of human engineering as a legitimate branch of the profession. In the engineering school a new department is needed for the full development of the field, headed by an engineer who will plan and direct the courses and, especially, will interpret in technical terms the separate contributions of the specialists from the related fields and correlate them with the basic engineering subjects.

Supersonic Air Cleaning

SMOKE and dust can be removed from the air by superpowered sound waves which are inaudible but can be felt with the hand, Dr. Hillary W. St. Clair of the United States Bureau of Mines Eastern Experiment Station, College Park, Md., reported at the 1949 national meeting of the American Chemical Society held recently in San Francisco, Calif.

Sound so intense that it can float lead shot in the air causes tiny smoke or dust particles to assemble in thin cohesive wafers, too heavy to remain suspended in the atmosphere, Dr. St. Clair stated. Pointing out that ordinary sound is audible up to a frequency of 18,000 vps, he said that 5000 to 50,000 vps can be used to clean air.

Although the most effective frequency range for sonic agglomeration is in the upper audible range, sound of these frequencies can be attenuated so it need not cause objectionable noise, he stated. If need be, the frequency can be raised above the audible range.

According to Dr. St. Clair, high-frequency sirens have been developed that have an output equivalent to several kilowatts of electric energy.

These powerful new sound generators, and possibly others yet to be developed, open the way for practical utilization of the effect on an industrial scale, he declared.

The effect of superpowered sound has been carefully analyzed by shooting these sound waves through glass tubes filled with smoke of various types, fogs of oil and water, quartz dust, and other common air pollutants, Dr. St. Clair continued.

It has been observed that the contaminating particles form wafers which are suspended in mid-air at intervals equal to one half the wave lengths of the sound, he said, noting that the time for agglomeration varies from a few seconds to ten or fifteen, depending upon the individual size and the concentration of the particles.

It is probably not widely known that sound waves exert a pressure against an obstacle in their path, because at ordinary sound intensities, this pressure is too small to be measured, he stated. At high intensities, however, such as those attained in sonic agglomeration, the pressure is great enough to be felt distinctly against one's hand if it is placed in the beam of the sound.

He said that it has been possible to support lead shot by a sound field set up between a reflecting plate and an electromagnetic vibrator. Sound of this intensity will exert a pressure of several grams per square centimeter against the reflector.

A complex array of forces combine to drive individual particles together, according to Dr. St. Clair, who said that the first theory to explain sonic agglomeration attributed the effect to the increased rate of collision resulting from the frenzied movement of the particles.

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[4] "Biotechnology. A New Fundamental in the Training of Engineers," by Craig L. Taylor and L. M. K. Boelter, *Science*, vol. 105, 1947, p. 217.

The INTERNATIONAL ROLE *of the* ENGINEER

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THE INTERNATIONAL ROLE OF THE ENGINEER

SINCE World War II the United States has developed a strong international conscience. As a nation, we have begun to take an active interest in the spiritual and material welfare of many foreign nations. Our present foreign policy recognizes the need for increased international co-operation in a world of shrinking distances.

The willingness for co-operation alone does not suffice. It must be implemented by effective action, which is to a great extent of an engineering nature. In order to achieve successful engineering co-operation on an international scale, industrial and engineering thinking must be adjusted to take foreign conditions into consideration.

The purpose of this article is to study the methods, the problems, and the consequences of adapting our engineering work to the conditions resulting from our country's participation in the economic life of other nations.

INTERNATIONAL ENGINEERING RESPONSIBILITIES

As a social figure, the engineer is like a missionary to the world. He has equipped himself through hard study and experience to provide a higher standard of living for his fellow men and to make their lives more pleasant. He has been entrusted by society with the task of translating theoretical science into practical achievements.

In the international field, he assumes the additional responsibilities of making existing technological achievements available to people living under very different conditions. He must introduce new locally needed products and present them in a manner which will enable the foreign customer to derive the greatest benefit from these products. Furthermore, he assumes the moral responsibility of interpreting our technical thinking and of transmitting some of our ideas to the people of other lands with whom he is in contact.

REQUIREMENTS AND PREPARATION

It is apparent that a special preparation is required for this engineering career in foreign service. A high degree of technical competence is a basic requirement, since the American engineer abroad finds himself in a rather isolated and exposed position. His usual sources of information and his services of technical aid are not readily available to him. He must rely to a great extent on his own knowledge and experience. Generally speaking, only the better technical man should be selected for foreign service.

But a great deal more than technical competence must be acquired. The successful understanding of a foreign environment requires an open mind. It implies the recognition of the basic equality of all human beings, and a realization of their desire for happiness. The engineer who represents our country abroad must possess a genuine interest in his fellow man, a desire to know and to help other people. He must have lived, and continue to live according to the principles of our democratic society.

Living in foreign lands requires great powers of adjustment. These can be developed by associating freely with many different people from all parts of the country, and by learning to live and work harmoniously with them. American universities with student bodies which represent a cross section of the country, offer an excellent opportunity for broadening the young engineer's human experience. The future engineer in practice overseas should make full use of this opportunity, while in college, to prepare himself for his contacts with even more different types of people at a later stage of his career.

The engineer interested in foreign service should acquire an academic background in subjects related to international life. He should study the history, social conditions, and geography of other countries. He should gain a sound understanding of international politics and economics. In these studies, he should read books giving different interpretations of foreign countries. In this manner, he will avoid forming biased opinions on any of these subjects. Furthermore, it is essential that he acquire a basic knowledge of the language he expects to use.

Besides creating this general background, the engineer, who plans to live and work in other lands, should make a specific study of the international aspects of engineering and science. He must analyze the extent of the technical and industrial development of foreign countries and gain an understanding of their standards of scientific instruction and research. He must learn to respect technical methods, codes of law and business practices which are encountered in other countries. Such an understanding of all technical methods and requirements will establish a convenient first basis of contact with foreign engineers.

The theoretical preparation must be affirmed and expanded by what may be called "experimental application." Traveling abroad is an excellent practical preparation for working in foreign countries. Languages can be mastered by living in a foreign country for a year or two. But even four to six months of intensive conversation with local citizens, preceded by an elementary study, will result in a good speaking ability on the part of the visiting student. Under these conditions speaking is simply learning. Social conditions, foreign ways of life, and specific methods are best understood by seeing and living with them. The young engineer will assemble information on local labor conditions, and on other factors which affect the choice of a suitable location for an industrial plant; he will make an on-the-spot study of industrial methods and procedures; he will evaluate the local standard of living. He will thus gain experience in formulating a composite opinion on the industrial and economic situation of a particular foreign area.

On the basis of this evaluation he will learn to differentiate between products which most efficiently could be produced locally and those which should be imported. He will begin to visualize modifications of American products, which will render them more acceptable to local markets. He will develop the art of understanding rapidly a foreign situation and of drawing workable conclusions.

The organized exchange of engineering students between countries would create opportunities for good international preparation at little cost and inconvenience to the student. Such exchange of students, if operated on an adequate scale, would favor the development of the needed international qualifications. The exchange method is especially promising since the student is exposed to the foreign environment at an impressionable age when he can still learn easily. He can free himself of juvenile misconceptions concerning foreign countries. At a later age his mind tends to be more closed, and, moreover, he is less free to undertake study trips.

APPLICATION AND POTENTIAL ADVANTAGES

By organizing a well-balanced educational program along the lines indicated in the foregoing section, colleges would produce a new professional type, namely, the international expert on technical affairs. The demand for such men will come from many different types of organizations and will cover a variety of fields.

Engineers with training in international affairs would form a valuable man-power pool for potential government service. There is a great need for competent experts qualified to carry out abroad administrative and technical assignments for our Government. The present reconstruction efforts and planned international co-operation require that good technical men be available for foreign service. The responsibility of working for the United States abroad should be entrusted only to individuals prepared adequately for the foreign environment.

The requirements of foreign engineering service for private interests are similar. The nature of the task of representing private industry abroad is more specialized, and the field of activity is more limited. The representative must be especially familiar with the local conditions prevailing in his particular field of interest. He must evaluate, moreover, economic conditions, and specific industrial requirements. He must know the habits of foreign people and understand their ways of thinking. He will, in this manner, be able to present his product in the most appropriate light and adapt his business attitude to the ways of his foreign customers. On the basis of a sound understanding of the country covered by his assignment, he can make constructive recommendations for adaptations of his products.

He can suggest new products to his home office for which local needs seem to create a good market. The man serving private interests must of course strive to conduct profitable business operations. But the individual's opportunity for advancement is greater in foreign service. His relative isolation from his employer places a greater responsibility on the engineer in foreign service. His contribution to the success of foreign work under his direction is more evident, and direct recognition must be given to him.

Improved relations between technical men in different countries will gradually bring about a steady exchange of scientific information. Unnecessary duplication of research will be avoided. Information about work carried on in one country might stimulate new interests in a far-distant land and lead to new investigations. Technical international co-operation will lead finally to the development of joint research projects by citizens of different countries, permitting a pooling of intellectual and material resources. (In this connection it is interesting to note the laudable attempt of some societies to present information concerning foreign work by publishing regular news columns on the subject. It is hoped that in the future gradually more space will be allotted to this department.)

The closer contact established by engineers and scientists will make it easier to resolve some international differences. People will discover how natural, social, and climatic conditions of a country have determined the behavior, the minds, and the bodies of its inhabitants. Foreign characteristics which differ from our own will appear less shocking when their reasons are understood. Close contact with foreign people will show that often their aspirations for a happy life are the same as our own.

The cause of world peace would be aided by such professional co-operation. The professional world has reached a state of complexity and specialization which requires for its full utilization the combination of the efforts of many countries. The tremendous progress of science has made it possible for many people to live a better life. When all the products of the earth and of the mind are made available to the peoples of the world, the possibility of war is reduced.

Modular Co-Ordination

NEW advances in a system for achieving construction economies by establishing uniform size standards is described in a report on "modular co-ordination" now available from the Office of Technical Services, Department of Commerce.

The report was prepared by the Modular Service Association of Boston which carried out a project in the field with the assistance of funds supplied by the Office of Technical Services as part of its $1,500,000 research program in 1946–1947 to aid U. S. industry.

Modular co-ordination calls for standardizing building dimensions on a four-inch and four-foot module. It is a system for simplifying plans in commercial, industrial, and residential construction by establishing uniform component sizes for the guidance of materials suppliers, engineers, architects, and builders.

According to the report, modular details have now been applied to chimney flue linings, stone sills, and two proprietary window products. These items are either on the market now, or expected to be shortly. Modular sizes have also been proposed for aluminum windows, kitchen equipment, toilet partitions, and shower stalls. Now under development are steel stair units, ceramic tile, porcelain enamel, steel lockers, and certain types of hospital equipment. Work is continuing on brick-veneer walls and various types of masonry units.

Despite the growing interest in modular co-ordination, the Modular Service Association points out that various difficulties have hindered its full adoption. Although certain manufacturers, for example, have announced "modular sizes," these sizes have not always been co-ordinated properly with other materials. Furthermore, even true modular materials cannot be employed to their maximum usefulness unless the builder or architect is fully acquainted with the entire modular system. The Association believes that the work done under the recent contract has helped to overcome these difficulties.

The report PB 88834, "Dimensional Co-Ordination of Buildings, and Materials and Equipment on the Modular System," 96 pages including committee studies and sample sheets, is available from the Office of Technical Services, Department of Commerce, Washington 25, D. C., at $2.50 per copy. Orders should be accompanied by check or money order payable to the Treasurer of the United States.

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

COMPILED AND EDITED BY J. J. JAKLITSCH, JR.

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context and credit to original sources is given.

Nuclear Reactors

THE Atomic Energy Commission is vigorously engaged in the process of developing nuclear reactors which will operate at much higher temperatures than previous reactors, and from which it is at least technically possible to produce electric energy. This was disclosed by Dr. Robert F. Bacher of the United States Atomic Energy Commission at a Science Conference celebrating the Seventy-Fifth Anniversary of Wellesley College, Wellesley, Mass., March 17.

He said that the enormous piles which were built at Hanford, Wash., during the war were primarily for the purpose of producing plutonium, and are today being operated for this same purpose. During the last two years, he revealed, there has been a program of rejuvenation of these reactors, which were showing signs of deterioration, as well as a major construction program to make new reactors to produce more plutonium.

Since the war, one new research reactor has been put into operation. This reactor, which is located at the Los Alamos Scientific Laboratory in New Mexico, utilizes plutonium as its fissionable material and is a step in the study of reactors which operate with high-energy neutrons. Another reactor, somewhat similar to the one which was built at Oak Ridge during the war, is nearing completion at the Brookhaven National Laboratory on Long Island. It will be used primarily for research and development work and will provide a major research instrument for the northeastern section of the United States.

The real work in the development of nuclear reactors is now gaining headway. This work, which is carried on at many laboratories, is centered in the Argonne National Laboratory near Chicago, Ill., the laboratory in which much of the development work leading to the construction of the Hanford piles during the war was done. The development program of the Commission is built around four major reactors which are now authorized for design and construction. These are a materials-testing reactor, a Navy power reactor, a high-energy breeder, and an intermediate-energy power breeder.

The materials-testing reactor is being constructed in order to study the effects of the intense radiations produced in a nuclear reactor upon the materials used to construct reactors. One of the major difficulties of the past two years has been the serious effects produced upon structural materials by these radiations. This reactor, which will be able to provide these radiations at an intensity not hitherto available, should greatly advance the studies of radiation effects and lead to the development of reactors which operate at higher power.

The Navy reactor is the first attempt to provide a nuclear reactor for a specific power need. This reactor will be a land-based prototype of a unit which it is hoped will be suitable to drive a ship. It may be possible to build a nuclear engine for ship propulsion which would be comparable in weight to the engine and fuel normally carried, and which would provide independence in cruising radius. Such a power source for any ship is interesting and has particular applications to Navy demands.

The high-energy or fast neutron breeder is a machine designed to operate with high-energy neutrons, and thus contains little material which would slow down or moderate the neutrons emitted in the fission process. So far, most of the work on nuclear reactors has been on machines which operate with low-energy neutrons. The main objectives of the fast neutron reactor are to explore one of the very interesting possibilities of reactors—the so-called breeding principle—and to produce at least small amounts of electric power. It may be possible to build a reactor in which the amount of fissionable material destroyed in the reactor is smaller than that produced by the neutrons emitted in the fission process. In such a reactor it would be possible to extract and use energy from the fission process and to produce more fissionable material than had been destroyed to obtain this energy. It looks as if such a machine is possible in principle. Whether or not it will be technically feasible is now being determined. If it proves to be technically feasible, the next step will be to find out whether it is economically feasible.

Another reactor, which is being designed and constructed by the General Electric Company near Schenectady, N. Y., is directed toward the production of useful electric energy and toward the achievement of a machine, operating with neutrons in the intermediate-energy range, which is able to breed new fis-

How to Obtain Further Information on "Briefing the Record" Items

MATERIAL for this section is abstracted from: (1) technical magazines; (2) news stories and releases of manufacturers, Government agencies, and other institutions; and (3) ASME technical papers not preprinted for meetings. Abstracts of ASME preprints will be found in the "ASME Technical Digest" section.

For the texts from which the abstracts of the "Briefing the Record" section are prepared, the reader is referred to the original sources, i.e.: (1) The technical magazine mentioned in the abstract, which is on file in the Engineering Societies Library, 29 West 39th St., New York 18, N. Y., and other libraries. (2) The manufacturer, Government agency, or other institution referred to in the abstract. (3) The Engineering Societies Library for ASME papers not preprinted for meetings. Only the original manuscripts of these papers are available. Photostat copies may be purchased from the Library at usual rates, 40 cents per page.

sionable material. This reactor, as well as the fast reactor, will have energy removed by the circulation of a liquid metal, thus providing heat at a temperature at which conversion to electric energy can be achieved efficiently.

He referred to the machine as an intermediate reactor because it operates with neutrons of intermediate energy. The reactor will contain some reflecting material which will lower the neutron energy but not as much of such material as it would contain if it operated with neutrons of low or thermal energy. Up to the present time no reactor has been built to operate in this intermediate energy region and our experience is very limited, he said.

Heat energy will be removed from the reactor by circulating a liquid metal. It is planned to utilize the heat carried off by this liquid metal to generate electric energy. It is also planned to test the possibility of breeding new fissionable material with intermediate energy neutrons. Whether or not such an intermediate reactor will be a successful breeder is now quite unknown. The designs for this unit are now well under way. Preparations at the site have been started and it is hoped that construction of the reactor will start during the current year.

Dr. Bacher also announced that to provide a suitable location for these new machines, the Atomic Energy Commission has decided to establish a reactor test station in the West. This test station will occupy probably 400,000 acres and studies are now being carried on to find a suitable location. (On March 22, the AEC announced that it has chosen a 400,000-acre area near Pocatello, Idaho, as the best site for a nuclear test station.)

Two reactors now being designed are scheduled to be built at the new site, the materials-testing reactor and the Navy reactor. The site was chosen to accommodate development reactors for many years to come, and hence must be adequate for machines far beyond these two units. With the establishment of this new site, the development of nuclear reactors, which is the backbone of the peacetime utilization of atomic energy, is now moving into a new era of accomplishment.

In addition to the nuclear reactors which are now being designed and are going to be constructed, a number of other studies of reactors for the future are being carried on, he revealed.

Probably most exciting of these, and also most long-range is, the development of a nuclear reactor to power an aircraft.

Also under consideration is whether a practical reactor can be constructed using natural uranium for fuel and designed to operate primarily for power production with minimum replacement and reprocessing of fuel elements. Whether or not such a unit is feasible is closely tied to the development work on reactor materials now being carried on as an important part of the reactor-development program.

The third new possible type of reactor, said Dr. Bacher, is called a homogeneous reactor. All reactors constructed so far have been, except for one small experimental unit, built upon the principle of embedding fuel elements in other materials which are then used for cooling, reflecting, and moderating purposes. For many years the question has been studied and restudied from time to time to see whether it would be feasible and practical to make a reactor in which these elements were all mixed together uniformly—hence the term "homogeneous reactor." It is hoped that these studies can be carried further, since, if they should prove successful, there is the interesting possibility that the nuclear reaction, the removal of energy, and the reprocessing of nuclear fuel could all be put together in one extended unit.

This program of reactor development is aimed at the exploration of new reactor principles. From the results obtained, Dr. Bacher pointed out, we should be able to design full-scale reactors to produce electric power in quantity.

As to the amount of uranium in the world to sustain an atomic-energy industry, Dr. Bacher revealed that an intensive program of research, development, and exploration for raw materials is under way. More uranium is available today than before the war, he said. New uranium fields are being hunted, and new methods of utilizing lower-grade ores for the production of raw materials are being vigorously pursued. There seems to be little doubt that in the future uranium and also thorium will be available in greater quantities than they are today, since in the past they have been of little use.

UNSCCUR

UNSCCUR—the United Nations Scientific Conference on the Conservation and Utilization of Resources—will open a three-week session at Lake Success, N. Y., beginning on August 17 and ending on September 6.

The ultimate aim of this conference is the enrichment of human life through dissemination of information. The immediate program of the conference is to take the first step in a world mobilization of the resource techniques and know-how, one of the essentials in bringing this enrichment to reality.

In beginning this mobilization, UNSCCUR will draw from the talents, techniques, and experience of scientists, engineers, resource technicians, economists, and other experts from all over the world. They will exchange ideas and pool their information on how the earth's resources can best be used for the improvement of living standards for everyone. The discussions will be carried out against the background of an urgent need for increased use of resources demanded by a rapidly growing world population. Topics will cover fields from ornithology to geology.

UNSCCUR is the first scientific conference to be convoked by the United Nations. One of the unique aspects of the conference is that missions to it will represent not governments but the science and technology of economic development. Scientists and engineers from all parts of the globe have been called to gather around a conference table to help each other build a better world through improved means of harnessing resources. Some 700 papers are expected from the 50 countries being invited.

Specific attention to methods of conserving and utilizing resources will be paid at the conference. The conference will devote approximately half of its program to this "interrelation" of resource techniques through plenary meetings on subjects of general interest to scientists, technicians, economists, and resource administrators, whatever their special field.

Opening the first section of its program, the conference will examine the state of the world's resources potential, measure its depletion, and delve into the legacy of its past waste and misuse. The conference will then give a brief world review of existing critical shortages. Under the general heading of "Using and Conserving Resources" the conference will take up such questions as the estimates of undiscovered oil and gas resources and trends in the use of metals.

Discussions will also be held on the development of new resources by applied technology such as the production of synthetic foods and new uses of plastic materials.

The plenary meetings will conclude with a review of experience in projects based on the co-ordinated application of resource techniques.

The other half of the conference program will be devoted to 60 section meetings where specialists can exchange methods and experience regarding specific problems and techniques. These section meetings will be devoted to the discussion of techniques for the conservation and utilization of the following resources: minerals; fuels and energy; water; forests; land resources; wildlife, fish, and marine resources. Problems of atomic energy will not be considered since this item is dealt with by the Atomic Energy Commission of the United Nations.

The objective of the section meetings is to highlight particular techniques which have practical value for expanding the supply of resources—either by conservation or by drawing wealth from previously economically unusable resources.

The conference was proposed by President Truman in a letter to the United States Delegate to the Economic and Social Council on September 4, 1946 (document E/139). In making the proposal, President Truman emphasized the relation of the conference to the problems of underdeveloped areas, stating: "It is my hope that such a scientific conference would bring together all the new techniques of resource conservation and utilization particularly for the benefit of underdeveloped areas, since the problems of these areas represent the hopes of millions of people for freedom from starvation and for opportunity in life."

Horsepower

HORSEPOWER, as every engineer knows, writes S. P. Bordeau, electrical engineer, Electric Machinery Manufacturing Company, in the March, 1949, issue of *Power*, is not the straining at the collar of our well-regarded four-legged friend, but a definite unit of the rate of doing work. We call this measure horsepower, he states, but is it not odd in a world of electricity, atomic power, and supersonic planes, that we should still envision power in terms of horses?

The present-day buyer of a 10-hp engine, or a 1000-hp electric motor, knows just what work he can expect from his investment. This definite, measurable guarantee is essential to modern industrial practice. But why, asks Mr. Bordeau, does the buyer specify his engine or motor by horsepower and how does he know what he is getting? For the answer, Mr. Bordeau turns to the history of the horse and the steam engine.

Lost somewhere in the mists of antiquity is the record of the first man who enlarged his own power by harnessing an animal. But wherever it was, it marked a milestone in our industrial age. By multiplying his own muscular power, man achieved a first long step to greater production.

Among the animals that have been used for power are the horse, camel, elephant, dog, and ox. Why then do we not use, say, "oxpower" instead of horsepower for the rate of doing work? The reason lies mostly in the evolution of the horse, a grass-powered engine. Over a period of millions of years, according to geologists, it went through a specialized change in structure to adapt for survival by a remarkable combination of power and speed.

For instance, the earliest known horse (Dawn Horse—*Eohippus*) was very small, standing 12 in. high at the shoulder, about the size of a dog. Roaming Wyoming's lush plains 50 million years ago, he had five toes in front, each tipped with a tiny hoof. By Oligocene time, 30 million years ago, the horse (Middle Horse—*Mesohippus*) began to look more like he is today. He had evolved in size to that of a sheep, had only three toes, the middle toe being distinctly bigger with an enlarged hoof. The horse (New Horse—*Neohipparion*) of about 3 million years ago was the size of a small pony. He walked up on his middle toenail, his outer toes no longer touching the ground. Greater running speed resulted from his longer stiltlike shanks. The single-toed horse (Western Horse—*Equus occidentalis*) once lived by the millions in North America, then mysteriously became totally extinct here. Modern horses were introduced in America by Spanish explorers of the sixteenth century.

Enduring, docile, and streamlined for work, the horse in harness was a natural choice for pulling loads and powering primitive mills. So when James Watt, in 1780, first put steam effectively in harness, he had only to look around him to see what power his engines would replace.

So long as Watt's first units were direct-connected to plunger pumps for raising water from mines it was sufficient to rate them simply by cylinder diameter, length, and number of strokes. This could be translated directly into pumping output. But when the engine spun a wheel and delivered rotative power it became of little use to tell the user the cylinder size.

A new method to express power had to be devised, and the inventive Watt quickly met the situation. To guide him he had information on how many horses could do the work his engine must do. Thus the engine's capacity could be expressed nicely in terms of the number of horses it would replace.

Enthusiastic, like most inventors, James Watt selected no ordinary horses for his horsepower standard. Rather, he experimented with the sleek strong Percherons drawing London's heavily laden brewer's wagons. Having them pull a variety of weights up out of a well over a roller with little friction, he first figured that a horse could raise 180 lb when moving at 180 fpm, or about 2 mph. This gave 180 × 180 or 32,400 ft-lb per min. Later, in 1783, after further experiments, he simply evened the figure to 33,000, and in the *Edinburgh Review* for January, 1809, the standard of horsepower was defined for the first time. It was formally stated as the work done in raising 33,000 lb one ft high in one minute.

Although it is known that a horse cannot work continuously at the standard so set, Watt's figure has never been modified. Down through the years it became firmly established as the power-quantity reference, and his exact formulation of this unit was a tremendous forward step.

Since Watt's time the power of steam has been vastly enlarged and made incomparably more adaptable and useful by conversion to the power of electricity. Electric motors have the unique advantage of providing concentrated rotative power at the job in economical, compact, easily installed, and adaptable form, at any size or speed.

For example, say, a motor delivers 1000 hp at about 3550 rpm. To do this, the motor must exert a continuous turning effort, or torque, of $33{,}000 \times \text{hp} \div 2\pi \times \text{rpm}$ at a one-ft radius, or 1480 ft-lb.

Matched with the motor in a tug of war, one of James Watt's powerful brewery horses might momentarily equal this pull. But Watt in his most inspired moments could not have dreamed how the concentrated forces of electromagnetism could be made to whirl this torque at 60 rps to produce the power of a thousand horses.

Photography

VU Emulsion

VACUUM ultraviolet emulsion, a new photographic material developed for identifying atoms or chemicals through analysis of their radiant energies may prove useful for study of the sun from rockets.

The new emulsion may be used in the thin atmosphere 250 miles or more above the earth, or in near-vacuum on the ground. It is sensitive to light far into the ultraviolet.

The VU emulsion, which was developed in Eastman-Kodak Company's emulsion research laboratory, has extremely close-packed silver grains, with very little gelatin. The gelatin of a normal photo emulsion absorbs ultraviolet light. The new emulsion, with little gelatin, enables the ultraviolet light to be recorded.

Ultraviolet rays of the sun are intense at high altitudes where the VU emulsion may be used. While the sun's rays in this form cannot penetrate the atmosphere, study of them is important because they cause electrical disturbances in the upper air which affect our weather and radio communications.

Extensive tests of the VU emulsion were made at Kodak. Air was pumped out of a torpedo-shaped device known as a vacuum spectrograph. The emulsion, placed in the vacuum, was exposed to a high-intensity spark rich in ultraviolet radiation. The test on the ground simulated conditions the emulsion encounters at high altitude.

Scientists expect that the VU emulsion will also advance research in atomic spectra for identifying chemicals or atoms through analysis of their radiant energies. It will be useful also for studies where the gelatin or normal photographic emulsions absorb radiation and do not permit photographic recording.

Thermoradiography

A new method of making "heat-radiation pictures" by photographing a glowing phosphor screen also was announced recently by Eastman Kodak Company.

The new technique, which is expected to have many uses in science and industry, is called "thermoradiography." It uses highly sensitive phosphors, which glow in the dark, to record the heat of objects over a wide range of temperatures.

Pictures have been made in this way of heated chemical apparatus, of a radio tube warming up, and of a teakettle of water boiling on a hot plate.

One picture, which demonstrates the sensitivity of the technique, shows a human hand, with thumb up and forefinger pointing. The warmth of the hand provided the radiation for the picture. The slight difference in the temperature of the hand compared to that of the air in the room was sufficient to register its image on the phosphor screen.

In a related technique, the sensitive phosphors are coated directly on an object to get a picture of its heat distribution. This use of the phosphors for direct measurement of heat is called "thermography."

The heat-radiation pictures are made as follows:

A screen is coated with the specially prepared phosphors. Through use of a curved metal mirror, the heat radiation of an object is focused on the screen. Here the image can be examined under ultraviolet light or can be photographed.

The image is a picture of the object against its warmer or cooler background. In the laboratory a picture of a piece of ice was made successfully, simply because it gave relatively little radiation compared to the warm air around it.

Differences in the heat of parts of the object can be recorded. Pictures of the teakettle and hot plate, for example, show the contrasting heat of each when the teakettle is warming up on the hot plate, and later when the hot plate is turned off and cools more rapidly than the kettle.

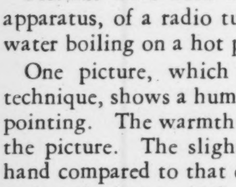


FIG. 1 PICTURE OF HAND DEMONSTRATES THE SENSITIVITY OF THERMORADIOGRAPHY

(Warmth of hand itself provided the radiation for the picture.)

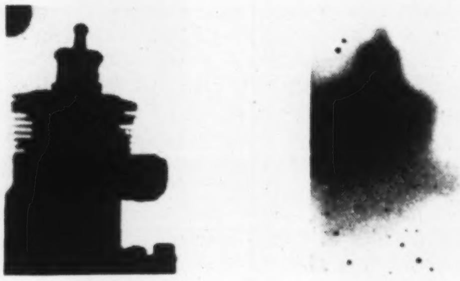


FIG. 2 SHADOWGRAPH OF A MODEL AIRPLANE ENGINE IS COMPARED TO A HEAT-RADIATION PICTURE OF THE SAME ENGINE IN OPERATION

Unusual temperature sensitivity is obtained in thermography, using the phosphors for measurement of heat directly, it was pointed out.

For example, an outboard motor might be painted with one of the special phosphors. When looking at the running motor under ultraviolet light, the effect is as if the motor were glowing like a hot stove in a dimly lighted room.

Where the phosphor-coated motor is fairly hot, it is dark blue in color. Where cool, it is light blue or nearly white. There is a brightness change according to temperature.

By measuring the brightness of the phosphor, temperatures can be measured at many points simultaneously.

Such a comprehensive picture of the heat distribution of an object, which can be recorded in still or motion pictures, has not hitherto been available to engineers and scientists. It is expected to have a variety of scientific applications.

It is reported that the phosphors show a 20 per cent change in brightness with each Centigrade degree of change in temperature. And thermography can be used for temperatures ranging from that of liquid air to 400 or 500 C.

Particularly high temperature sensitivity was obtained through the use of so-called phosphor "deactivator" materials, such as nickel, in making the phosphors. These materials are usually avoided because they reduce brightness. Using them, however, increased temperature sensitivity.

Drilling Rig

THE world's largest Diesel-powered drilling rig (see frontispiece on page 378 of this issue) manufactured by The National Supply Company, Pittsburgh, Pa., is now in process of drilling one of the Superior Oil Company's deepest wells in southwestern Wyoming. A depth of more than 16,500 ft has been attained without any major difficulties.

The rig is powered by three supercharged dual-fuel Diesel drilling engines with 2010 combined horsepower. Two pumps, one rated at 825 input horsepower and the other rated at 495 input horsepower, are driven from the three-engine-drive group. An additional pump is independently driven by two engines identical to those on the drawworks. The rig has a combined horsepower of 3350. Hoisting equipment, including a 7-sheave 630-ton crown, and a 6-sheave 540-ton traveling block used with a $1\frac{1}{2}$-in. wire line, is said to represent the largest of its kind in the world.

One of the features of the drawworks which has proved successful on this first well, is a new micromatic drilling control. The driller merely turns a valve handle to maintain the desired weight on the bit, the rate of penetration in feet per hour being indicated on a feedometer. The drum is driven by positive mechanical connections through a reduction gear by a hydraulic motor. This motor is powered by an oil pump driven from the rotary countershaft. Thus when the rotary machine is stopped for any reason, the control will automatically discontinue feeding the drill string. It is reported that this "feed off" has proved so dependable that the drillers can now confidently leave the drillers' position for short intervals to supervise other work around the rig. There also has been a decided saving in the number of bits used, since the operator has a precision control for feeding at the optimum rate.

A shaft drive from the drawworks to the rotary machine eliminates the former chain drive, which has been an obstruction to efficient working of the drilling crew. The rotary is driven through a separate transmission, which permits a relatively slow speed for unscrewing the pipe when coming out of the hole in one of the higher hoisting speeds.

A rather unique method of dynamatic brake hookup is utilized on this large rig. A master electric switch is hydraulically operated from a pressure diaphragm installed on the dead line. When the weight suspended in the derrick exceeds 65,000 lb the switch is "on," allowing the brake to be energized in the normal manner by the drawworks brake handle. When the weight is less than 65,000 lb, the master switch is "off," and the dynamatic brake cannot be operated regardless of the fact that the brake lever may be applied.

One of the greatest improvements to be incorporated in a modern power rig is the drive from engines to drawworks and pumps through hydraulic couplings. These couplings are mounted adjacent to each engine, on the engine extension shafts. An adjustable sliding scoop can vary the amount of fluid in the coupling and can completely empty it, thus eliminating the necessity for an engine disengaging clutch. The scoop, which is air-operated by the driller, regulates the amount of fluid in the coupling, and therefore the degree of slip. By varying the engine speed and the slip of the coupling, a wide range of speed and power is available for the pumps, drawworks, and rotary.

An example of one of the advantages offered by the hydraulic coupling was realized during reaming from the surface pipe to a depth of 9881 ft. The rig was set up over an old 9-in. hole and reamed to 11 in. The rotary table was operated with a high transmission speed ratio, the speed being reduced by slipping the No. 1 engine coupling, thus limiting the power transmitted to the table. When torque built up in the string due to excessive cuttings or cave-ins, the coupling slipped completely, stalling the table, and eliminating the danger of a twistoff. This condition was actually encountered several times.

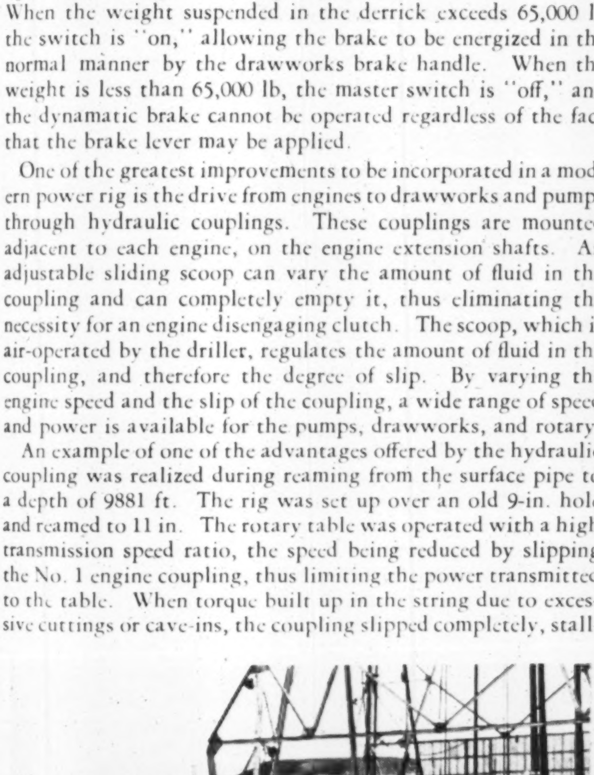


FIG. 3 THREE SUPERCHARGED DUAL-FUEL DIESELS ARE SHOWN ON DERRICK FLOOR

Although it has not proved necessary at the present depth, the rig is equipped with large atmospheric air chambers enabling compounding of the power pumps. These chambers are being used successfully as pulsation dampeners at the present time. As a result of past experimentation it has been found that the hydraulic coupling is a valuable adjunct, if not a necessity, to successful pump compounding. Compounding was carried on for a short period between 11,000 ft and 12,000 ft to test the installation; this operation was reported to be successful.

Design for Peace

IN an address on "design for peace" which he gave before the American Institute of Architects in Houston, Texas, recently, Sumner T. Pike, United States Atomic Energy Commission, said that it was right and proper that we should take into account the new hazard of warfare that results from the release of the unprecedented blast and heat of an atomic bomb as well as the unseen radiation. It is also important that we pay close attention to the strategic dispersal of our key production centers, weighing this factor with all others in trying to improve the efficiency of our production machine. But it is immoral and infamous for us to abandon the basic premise of our national life by diverting our means and our energies into such proposals as putting steel mills underground and dislocating our economy in an attempt to gain at best partial protection from an uncertain hazard.

We should have a strategically more desirable dispersal of our centers of production, but the economic factors which influence such a distribution are far more compelling than the possible avoidance of an atom bomb. This means simply that when we have good economic and social reason to move industries, we move them, taking all the profit which accrues in reducing strategic vulnerability.

It means too, he stated, if you are designing a building you don't double the cost by designing it to withstand an atom bomb. It would be most difficult to design a building to withstand an atomic-bomb burst within a half mile, so your first compromise is with the specific hazard. And if you designed all new buildings to withstand such a burst up to a full mile, the burden placed on the users of those buildings would do more to reduce the war potential of the nation than the protection would be worth.

But if you are designing a new factory, an office building, or a new residential community, you will find that the measures you employ to reduce fire and traffic hazards, to provide recreation and avoid crowding, also afford a very sensible measure of protection against atomic weapons. In other words, the threat of atomic warfare provides renewed justification for practicing the things we know are good for other reasons. The greatest good for the nation, and this means the greatest defense strengthening, will come from the most progressive design for the job to be done by the structure, whether it is to house school children or a jet-engine factory.

Mr. Pike declared that we must be intelligent enough to realize that the best defense against an atomic bomb is, as Robert Oppenheimer has said, not to be there when it goes off. In other words, space is the best defense. We must also be realistic enough to realize that our cold-war opponent has more of this type of defense than anyone else.

He suggested that architects and engineers stop worrying about building atomic-bombproof buildings, or about putting factories underground—except for those few installations which the national defense may mark as priority targets—and keep in mind that our strongest defense or the best offense in either a cold war or a hot war is the healthiest and best educated population and the most efficient industrial machine. You may increase the reinforcement in industrial structures and bridges, thickening the concrete and putting in cross-bracing in these and ordinary commercial buildings. You may want to use noninflammable materials in all structures, especially dwellings. But it will be the rarest case, he pointed out, in which you will greatly change a building design solely for reasons of defense against atomic bombs if the change interferes with the primary function of the building, or if the change results in a burden on the user which lowers his ability to do a job that is important to the country.

According to Mr. Pike, most of the things that help make a building resistant to the effects of atomic bombs, or which will minimize the casualties of the personnel within the buildings, are things you do every day. Additional things that our cities should do, such as the designing of gas, electric, and water-distribution systems to minimize disruption, make sense for reasons other than the hazards of atomic bombs. Most of our great cities could well study these services with a view to improving them and making them more disasterproof, but it is not recommended that any city in America burden itself to the extent required to revamp its utilities systems just to make them proof against atomic-bomb bursts.

In conclusion he stated that we all should keep in mind, in facing all of the problems of the atomic age, that the things that make America great in peace are the things that make her strong in war. First is that our people have a life worth defending. This and the things that flow from it are the best possible weapons in a cold war. They make up our war potential when peace is lost. To design for peace is our best defense.

Interim Computer

DESIGN and development work supported by the U. S. Air Force is well under way at the National Bureau of Standards for the construction of a small-scale electronic computing machine to be used until the several large-scale machines now being built become available. The new high-speed machine, to be known as the NBS Interim Computer, will perform a substantial portion of the computation work of the Bureau's laboratories, solving many problems until recently considered impossible of solution. It will also aid in computing machine development at the Bureau and will provide important training and operational experience for personnel of those agencies that plan to operate the more complex electronic computers as soon as their construction is complete.

In its essential elements, the new Interim Computer will be similar to the EDVAC (Electronic Discrete Variable Automatic Computer), an electronic digital computer now under construction for the Army at the Moore School of Electrical Engineering, University of Pennsylvania. The NBS machine will have a memory capacity of 500 "words," or series of numbers, in contrast to the 1000-word memory to be built into the EDVAC. Initially, the input and output equipment will be punched paper tape instead of magnetic recording wire. Although the number of commands the calculator can obey is substantially reduced, its computing power should be of the same order of magnitude as that of the EDVAC. It will accept numbers in binary form which are the equivalent of more than 12 decimal digits together with algebraic sign. The average time for addition of two such numbers will be 864 microseconds; for multiplication, 2800 microseconds. Operating at this high speed, the NBS Interim Computer will be an extremely powerful computer system, capable of solving many of the problems—considered insolvable only a few years ago—which are now handled by the famous ENIAC (Electronic Digital Numerical Integrator and Computer) located at Aberdeen Proving Ground, Md. It is hoped that the Interim Computer will be assembled and ready for testing by the summer.

Plans are also being made by the Bureau for the design and construction of another automatic computing machine for its West-Coast laboratory, the Institute for Numerical Analysis. Present indications are that the high-speed memory for the machine will be of the electrostatic type based on the standard cathode-ray-tube memory device developed at Manchester University in England. This project will not only provide a more powerful computing facility at the Institute for Numerical Analysis but should also furnish an excellent opportunity for the study of the parallel type of computer.

New Jet Fuel

TO increase the U. S. Air Force's combat potential in event of a national emergency, and to conserve the nation's natural resources, a new fuel has been developed for jet-propelled aircraft which will make more jet fuel available per barrel of crude oil than the old type of kerosene (JP-1) used in jet aircraft.

The new fuel, known as AN-F-58 (Army-Navy Fuel No. 58), is basically a gasoline-type fuel with an octane rating varying between 50 and 65. The fuel was developed by the Air Force, Navy, NACA, and the petroleum industry.

By changing the process of distilling crude oil and blending the distilled products, a higher percentage of usable jet fuel is produced from a given quantity of crude oil than with the prior method of producing kerosene. Despite an increasing use of jet aircraft by the Air Force, less crude oil will be required to supply jet-engine fuel than would have been required using the kerosene-type fuel.

It is believed that unit cost of the new fuel will be approximately the same as the kerosene.

Modification of the individual airplanes to use the new fuel will be slight, consisting of modifying fuel pumps and relocating various items of electrical equipment.

With the new fuel, performance at altitude will be slightly improved and cold-weather starting will be easier.

Soviet Aircraft

A SERIES of photographs and descriptions of new Russian airplanes, appearing in *Ordnance*, January-February, 1949, indicate that the USSR has gone all out for the jet engine, just as have the Americans and the British. They show a distinct German flavor in their design, and rightfully, because the Russians took all the Nazi aircraft factories and engineers they could find in the closing days of the war and moved them eastward.

Many German aircraft plants were in Soviet-occupied territory, including a large number of famed component constructors. The Arado, Blohm and Voss, Dornier, Focke-Wulf, Heinkel, and Junkers concerns were among those that were added through the fortunes of war to the Russian accumulation of plants and scientific and technical man power. The Russians also captured many plans for projected jet and rocket-powered military aircraft and the men who drew them. These men are now working for rubles behind the Moscow meridian. That is why the jets that foreign observers see in Moscow have a German look.

American aircraft experts who have studied photographs and drawings of new Russian jet fighters have said that the most promising looking of the lot is the new Yak jet fighter. Looking remarkably like the American Air Force's Republic Thunderjet F-84, the new airplane is touted by its admirers as being in the 650-mph class. This would make it as fast as the U.S.A.F.'s best—the F-86—which has gone 670 mph officially.

According to the article, the power plant in the Yak jet may be the British Nene jet engine which can turn out 5000 lb thrust. The Russians bought a few dozen of the Nenes before international repercussions caused restriction of shipments from England. The United States also is using it in its F9F Navy jet fighters.

The Russians also were buying Derwent jet engines and reportedly got about 60 of the two types before the British Board of Trade clamped down on any more deliveries.

The article points out that in the new Yak jet, Russians apparently are getting away from the underslung jet-engine mounting which characterized most of their other planes—fighter and bomber alike. The airplane features an extremely thin wing, popular with the fastest fighters; high elevators to escape the air turbulence behind the wings; and a bumper under the jet exhaust pipe to protect the tail section in the event of a nose-high landing.

The Yak somewhat resembles also the Mikoyan single-jet fighter, another of Russia's newer aircraft. This Mig research aircraft looks somewhat like the Navy's FJ-1 shipboard fighter, with its nose air scoop and fat-bellied appearance.

The Mig-7 jet, it is stated, is powered by probably two German BMW 003 turbojets, each of 1750 lb thrust. Some of the Mig's structure resembles the Messerschmitt ME-262 fighter, which worried allied bomber formations over Germany during the war, particularly in side view, in tail unit configuration, and in fuselage cross section. This, however, is not necessarily evidence of German assistance in designing. Maximum speed is believed to be around 600 mph.

The Yak-15, another type, had the wings, elevators, and the "leaning-forward" fin and rudder closely resembling those of the Yak-3 and 9 prop fighters. Wing span is about 32 ft, smaller than the U. S. fighters. As usual, performance figures are lacking, but appearance indicates it could do well over 500 mph. Its pilot has poor visibility, due to location of the cockpit far back on the fuselage behind the wing.

Another Russian jet fighter is the Red version of the German DFS-346 jet research fighter. This bullet-shaped airplane also featured a nose air scoop, slightly sweptback wings, and elevator surfaces which are mounted on the extreme top of the rudder.

American jet experts, the article indicates, are interested in the Ilyushin four-jet bomber, pictures of which have appeared in *Aviation Week* magazine. Its four underslung jet-engine nacelles resemble those found on the Boeing B-47 jet bomber, but its fuselage is more like that of the Martin Marauder. This high-wing monoplane's tail turret looks like that found on the Boeing B-17.

The Russians also have a twin-jet medium bomber, the Tupolev. Its clean lines and general appearance are similar to its ancestor, the TU-2 piston-engined medium bomber and attack airplane.

The Russians' seeming preoccupation in producing jet fighters that will serve as interceptors rather than ground-support aircraft indicates what might be a change of military thinking behind the Curtain. It is a well-established fact that jet fighters make poor ground strafing planes because of their extreme speed which makes precision firing difficult. If the Russians are to continue their strong bent for hitching their planes to their infantry, it may well be that they intend to use the jets for intercepting enemy planes and will continue to use such World War II planes as the Yak-3 and 9, the LA-5, and the TU-2 for close air support.

The Russians do not seem to have copied any of the airplane designs of the Americans to any extent, except possibly that of the B-29. How many aircraft of this type are in service now with the Russian Air Force is not known, but lively argument has revolved around the TU-70 transport plane, which contains many Superfortress overtones.

During the war, several Superforts were forced down in Russian territory near Japan. Being neutral, Russia interned the airplanes and soon liberated the crews. Nobody knows what happened to the airplanes, but the TU-70 certainly has earmarks of the Boeing bomber. Many structures of both aircraft are identical in shape and size.

Russia is reported to have about 14,000 warplanes in operational service and another 10,000 in reserve. Of the total, more than 5000 are fighters, and of these, 1000 are new jets. More than 1500 Russian airplanes are land-based torpedo bombers. During the war, Stalin claimed aircraft production reached 40,000 airplanes a year. The U. S. turned out 96,318 in 1944, but our airplanes were heavy metal jobs, not lightweight plywood craft. In airframe weight, the U. S. outproduced the USSR by from five to ten times.

Standardized Boilers

THE benefits to be derived from standardized design of industrial boiler units were appraised by Donald S. Walker, Mem. ASME, vice-president, Combustion Engineering-Superheater, Inc., New York, N. Y., at the recent Fuel Engineering Conference of Appalachian Coals, Inc., held in Detroit, Mich.

The main reasons for advocating standardization are the ever-increasing costs of labor and material. World War II proved that boiler plants could be built at construction rates previously felt unattainable. This was accomplished by substantially duplicating existing designs and plants. Similar advantages may be realized in peacetime.

Mr. Walker termed "engineers' whims" on the part of the manufacturer as well as the purchaser as a cause of much unnecessary expense, and asked for specification of certain basic items, leaving details to the boiler manufacturer. He stated that his company had standardized on industrial boilers of 250 psig, 500 psig, and 700 psig, with capacities from 10,000 to 200,000 lb per hr steam output. For these units design is fixed, with outlets, for example, located where shown—and not several inches from that point. In this manner, shipment can be made in reasonably short periods at a price substantially below a tailor-made, specially designed unit.

Standardized units of this design could serve well over half of the average industrial installations within the capacity range. In new plants without existing building limitations they should be suitable for nearly all installations.

Instead of awaiting preparation of detail drawings, purchase of standardized units makes possible almost immediate issue of foundation plans, enabling an earlier start in construction. The consulting engineer, however, still has an important role to play, especially for industrial plants with limited engineering staffs. The small percentage spent for an informed, competent, and experienced consulting engineer is more than justified in the long run.

Boiler manufacturers do not like present high prices and long deliveries. Standardized design of industrial boiler units is one way to reduce both.

Electron-Diffraction Instrument

AN instrument which uses a stream of electrons to study a layer of metal less than a quarter millionth inch thick is aiding engineers of the National Advisory Committee for Aeronautics in their search for better metals and lubricants for jet engines, it was announced recently by General Electric's Special Products Division.

Developed by G-E, the electron-diffraction instrument is used in determining the effects of various lubricants and in friction studies of polished-metal engine parts. Engineers explained that ordinary lubricants are not adaptable to high speeds and temperatures inherent in jet-engine operation, and that new lubricant therefore must be developed.

Another NACA group has been using an electron-diffraction instrument in attempts to improve high-temperature metals.

With the instrument, engineers can detect in a few seconds natural films which emanate from the steel itself and chemical changes produced on the surfaces by lubricants. These chemical changes, they said, are not visible under a microscope, and formerly could not be detected with such equipment.

By subjecting the metal parts to temperatures and speeds which simulate actual flight conditions, and then examining the parts with the instrument, the researchers have been able to identify specific film materials normally deposited on the bearings when the engine operates. Used to study parts which have been worn by tests, the device helps engineers discover and minimize the causes of friction.

G-E electron diffraction instruments also have been used to study corrosion, surface deposits, paint pigments, inks, and dyes.

In operation of the instrument, electrons are "boiled off" a white-hot tungsten filament and focused into a beam by a magnetic "lens." For one type of work the beam is then passed through a two-millionth-inch-thick section of metal and produces an image on a fluorescent screen or on a piece of ordinary photographic film.

In other applications of the instrument the beam is directed to a metal surface at an angle. Tiny projections on the surface diffract the electrons and form the image.

The image produced is different for each material, and both the surface conditions and crystal arrangement of the molecules of metal can readily be determined.

Since electrons will not pass through air freely, the chamber in which they travel is evacuated to a pressure of approximately one eight millionth that of normal air pressure.

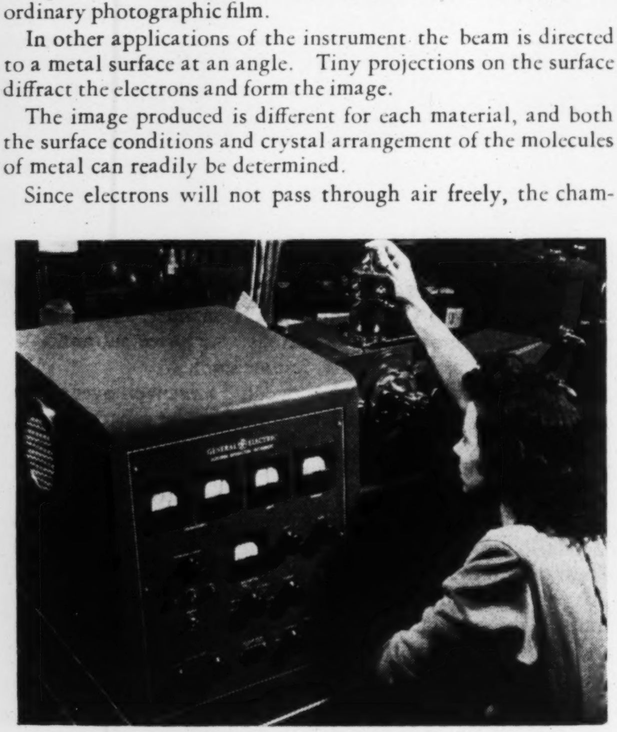


FIG. 4 ELECTRON DIFFRACTION INSTRUMENT IN OPERATION

Paper Furniture

A NEW material for making furniture has been proposed as a result of experiments at Armour Research Foundation, according to *Science and Appliance*, February, 1949.

This new furniture material is wood pulp. Manufacture is essentially a papermaking process with the difference that the dispersed cellulose fibers are caught and drained on a form shaped like the seat or other element of the finished article instead of being laid down flat. The pulp is built up to proper thickness on the die, drained and dried, impregnated with resin (and with dye, if color is desired) and then cured by heat alone or by heat and pressure in a pair of matching dies. Upholstery can then be nailed on, or the material can be used bare. The surface is said to look and feel warm, free of the coldness of metal and plastics.

Chair designs can be molded, it appears, so as to avoid joints and other weak places. Intricacy and cost of dies would be limiting factors. Material costs given are low. Tests have indicated ample strength. No claims are made for lightness, but the material might seem suitable for making pieces of furniture that the average woman can handle.

Cold Solder

SOLDERS made from powdered aluminum may replace the older-type solders which had to be melted and "flowed in" to dents and other damaged areas of automobile bodies. The new solders are said to require no heat and thus avoid damaging adjacent painted surfaces. Several successive applications can be employed to build up thicknesses as much as one inch.

The Reynolds Metals Company, Louisville, Ky., has actively aided the development of these materials and is now supplying large quantities of aluminum powder to concerns making the new-type solders which are now available.

These "cold" solders are doughlike, about the consistency of plastic wood. When applied by spatula or wiper, the solvent evaporates and the metal mass soon hardens sufficiently to be filed or sanded. It adheres strongly to a properly cleaned surface. When sanded smooth, it provides an excellent base for paint, enamel, or lacquer coatings.

A wide variety of applications for these solders are being studied. One of the most important applications already extensively explored is the repair of automobile bodies and fenders.

Repairing dents or holes in thin sheet forming auto bodies and fenders may be both difficult and expensive when attempting to do the work by conventional soldering or welding methods. However, use of the new cold solders is claimed to be exceptionally easy and effective.

Applying the material is simple. First, the area surrounding the hole or dent must be cleaned thoroughly. Sanding or buffing is recommended. The composition is then applied as desired to build up the damaged part. It is not necessary to pay particular attention to getting a smooth surface when applying the material, although the smoother the surface the easier it will be to obtain the final smooth surface desired.

After a period ranging from 20 to 30 min for thin coatings, the composition will have become hardened. Any surplus material can then be easily removed by use of a file or sandpaper. Sanding and buffing to a smooth surface for painting is greatly

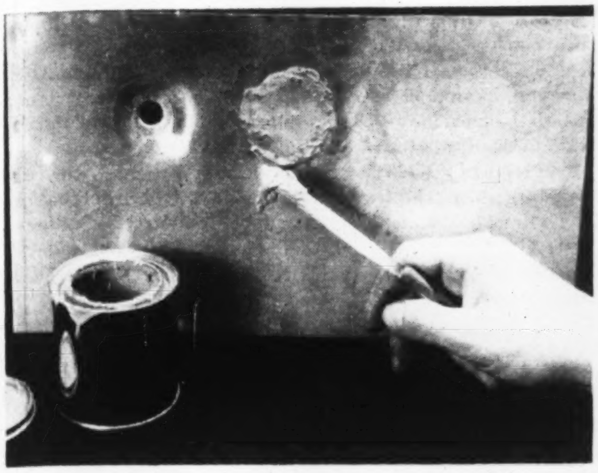


FIG. 5 OF THE THREE HOLES LIKE THAT AT LEFT ORIGINALLY IN THIS SPECIMEN, THE CENTER ONE HAS JUST BEEN FILLED IN WITH ALUMINUM PUTTY WHILE THE ONE AT THE RIGHT, PREVIOUSLY FILLED IN, HAS BEEN SANDPAPERED SMOOTH TO COMPLETE THE REPAIR

facilitated because the composition looks and acts just like metal once it has set. It blends into the surrounding metal without cracking around the edges. It will even withstand a slight amount of bending without breaking.

Reports From Germany

Plastic Aircraft Tooling

GERMAN manufacturers of aircraft tools found an unusual variety of uses for compressed impregnated wood, methylmethacrylate, and phenolic sheet materials but scarcely used phenolic and cellulosic casting resins for aircraft tools, according to a report now available from the Office of Technical Services.

The report discusses in detail the activities of the Kopperschmidt firm of Blumberg, Baden, which was particularly active in the production of impregnated wood and Plexiglas tools and instruments. In addition to producing "blister" observation ports for aircraft, the firm experimented with embedding minute nickel-chromium wires in Plexiglas to produce automatically heated windows for high-altitude flying. It also perfected novel inspection methods for the checking of transparent plastic materials.

Because their original samples were reported to be of unusual quality, Kopperschmidt produced several thousand cut Plexiglas lenses during the latter part of the war. No solution was found, however, to the problem of surface softness.

Silver vapor coating of plastic windows for aircraft was used in Germany to reduce searchlight glare in night flying and the process, adapted to other metals, was considered for use as a hard protective coating for plastic surfaces, or as an electricity conducting layer for defrosting. Experimental mirrors were also made by the process.

PB 78210, "Plastic Aircraft Tooling and Tooling for Transparent and Optical Plastics," 221 pages including charts, tables, and illustrations, sells for $5.75 per copy. Orders should be addressed to the Office of Technical Services, Department of Commerce, Washington 25, D. C., accompanied by check or money order payable to the Treasurer of the United States.

Rubber Industry

A new survey report on the wartime German rubber industry is now available to the American public, the Office of Technical Services announced recently.

The report is a review of all the technological information secured by Allied investigators on German processing, production, analysis, and testing of synthetic rubbers, especially the Buna and Perbunan varieties, as well as on the manufacture of leading rubber products. An annotated subject bibliography of 475 documents is included.

Among the high lights of the report is a section on German apparatus for the testing and analysis of rubber. This includes several novel and promising devices. The report also contains a comprehensive listing of German trade names for rubber and rubber chemicals which should be useful to the researcher examining other documents.

Practical working details of various processes, such as the thermal plasticizing of Buna rubbers, reclaiming, and the bonding of rubber to fabrics and to metals, are included in the report. Latex studies are also covered, as are methods not well known in this country for exploring butadiene-styrene polymers.

"The Rubber Industry in Germany During the Period 1939–1945," (B.I.O.S. Over-all Report No. 8), 112 pages including index and bibliography, may be obtained from the British Information Services, 30 Rockefeller Plaza, New York 20, N. Y., for 90 cents per copy.

Infrared Developments

Certain phases of infrared experimentation and the development of equipment for infrared transmission and detection advanced much further during the war in Germany than in the United States, according to a summary report on German infrared technology now available from the Office of Technical Services.

The Germans, in concentrating on military applications, also perfected devices for photography, spectroscopy, and other uses promising wide industrial applicability.

The report is a comprehensive survey of the present state of knowledge on infrared based on the documents secured abroad and now declassified by the U. S. government.

"Seeing in the dark" had great military implications to the German government, and devices developed for this purpose were used for night driving, aircraft spotting, and short-distance wireless communication systems. Great strides were made in perfecting infrared radiators, filters, and photoelectric cells, all of which offer possible uses in industry.

The report discusses studies of infrared atmospheric transmission phenomena; photocell and phosphor detectors; image conversion tubes; and photography by both sensitized-silver emulsion and evaporative methods. Several developments, such as those on electro-optical systems and on the induction generators, are felt to have implications completely outside the infrared field.

PB 95308, "German Wartime Developments in Infrared," 45 pages including illustrations and an extensive bibliography with its own subject index, sells for $3 per copy. Orders should be addressed to the Office of Technical Services, Department of Commerce, Washington 25, D. C., accompanied by check or money order payable to the Treasurer of the United States.

Oxygen Production

Detailed information on the large-scale production of oxygen in Germany is included in an Office of Technical Services report.

Equipment of the Messer Company, chief German manufacturer of large-scale air-separation plants of other than Linde-Frankl design, is discussed fully in the report. Other subjects include the physical constants of gases; the acetylene hazard; operation at low pressures only; the Heylandt process; and the Kapitza (Russian) process.

The description of the Kapitza process, of great interest to U. S. technicians during the past two years, was obtained through an interview with Dr. Linde, German authority on oxygen production. Dr. Linde questioned the theoretical efficiency of the process, and said that little is known concerning the extent to which actual installations have been made.

In the discussion of the acetylene hazard in oxygen production, the report points out that acetylene is sometimes present at the air intake in concentrations sufficient to produce a definite explosion hazard during the oxygen-production cycle. Information is given on methods for determining the presence of acetylene and other hydrocarbons in liquid oxygen; and the successful use of recent silica gel adsorbers in removing these impurities is discussed.

Throughout the report references are made to the commercial use of oxygen in quantity. There is evidence that while the production of oxygen in purities up to 99 per cent requires rapidly increasing amounts of energy, its manufacture in concentrations of less than 95 per cent is not economic. It is believed that a better method for obtaining low-concentration oxygen is to mix a high-purity sample with air before use.

The report, in addition to a special bibliography, and list of personnel and plants checked, contains 51 figures showing data relating to the large-scale production of oxygen.

PB 88840, "Large Scale Production of Oxygen," 124 pages, is available from the Office of Technical Services, Department of Commerce, Washington 25, D. C., for $3.25 per copy. Orders should be accompanied by check or money order payable to the Treasurer of the United States.

Natural-Color Photography

A comprehensive survey of the German "Agfacolor" process for natural-color photography is now available from the Office of Technical Services.

The report attempts, in its manner of presentation, to meet the needs of the technician, the motion-picture worker, and the photographer. While full technical details of the principal aspects of the Agfacolor process are included, subjects are introduced, where possible, in their simplest or most fundamental terms.

The report is divided into four main sections which deal with: physics of natural-color photography; the Agfacolor process; processing Agfacolor material; and the use of Agfacolor material in photomechanical reproduction. Eighty-five drawings are included in a special appendix to depict the principles discussed in the text.

Historical background on the development of natural-color photographic processes is given in the report, which contrasts the advantages of the Agfa process for transparencies, prints, and motion pictures against the techniques that preceded it. The report concludes that the value of the Agfa process is demonstrated by the fact that it was widely adopted in Europe even though it was not fully ready for use until 1939, at the outbreak of the war.

Production of Agfacolor diffusion-proof dyes, upon which the color is based, grew out of the search for a grainless developer to be used with monochromatic film, according to the report. A complete discussion is provided on the chemistry of the appropriate dye-producing groups.

The use of Agfacolor materials in taking pictures, developing, and printing them is covered in detail. Additional sections deal with special problems such as darkroom illumination; the reproduction of sound tracks for color motion pictures, and an explanation of the usefulness of Agfacolor material in photomechanical processes calling for separation negatives.

The report, PB 79559, "The Agfacolor Process," 169 pages including illustrations and diagrams, is available from the Office of Technical Services, Department of Commerce, Washington 25, D. C., for $4.25 per copy. Orders should be accompanied by check or money order payable to the Treasurer of the United States.

Liquid-Oxygen Converter

A NEW oxygen converter system using liquid oxygen instead of the gaseous type is being devised by engineers of the Air Materiel Command's Aero Medical Laboratory, Wright-Patterson Air Force Base, Dayton, Ohio, according to the CADO *Technical Data Digest*, March 15, 1949. This new system will mean increased safety for fliers as well as a saving in weight and space required for the oxygen-breathing systems used in present-day aircraft.

The entire mobile oxygen-liquefaction plant can be contained in one trailer truck. The trailer is parked on a corner of the flying field and fills the needs of aircraft with the aid of storage tanks. For use at remote bases, where oxygen-manufacturing equipment would prove impractical, huge storage tanks to hold as much as 1700 gal of the liquid are being designed. C-74 transports will be used to haul each of these tanks. The transportation of an equal amount of gaseous oxygen would require about $4^{1}/_{2}$ times as much space, and weight would be increased by about 80 per cent because of the number of containers used. Testing of the converter is being made in B-17's.

With all this saving of weight and space, the volume of oxygen available for human consumption is increased by 44 per cent. This is possible only because when changing from a liquid to a gas, the relative volumes are in a ratio of 1:800, which means that 1.0 cu ft of liquid oxygen will provide approximately 800 cu ft of gaseous oxygen upon vaporization. This fact, suitably applied, is the principle upon which the converter operates.

The converter consists of a metal container for the liquid oxygen with a vaporizing coil and the necessary safety valves and specially designed operating valves. The liquid, upon vaporization, is forced through the oxygen system due to the pressure formed by the change from a liquid to a gas.

The preparation of liquid oxygen involves some rather complicated machinery. The mobile unit, all contained in one trailer, can produce 80 lb of liquid oxygen an hour, which, in the gaseous form, would be about 1000 cu ft. One gallon weighs about $9^{1}/_{2}$ lb in comparison to $7^{1}/_{2}$ lb for an equal amount of water. Each trailer equipped for the manufacture of oxygen has its own power plant, air compressor, air purifier, refrigeration unit, and air-separator group.

The power-plant group furnishes all the mechanical power for the air compressor and the refrigeration units as well as the electric power for the air purifier, air separator, and the 115-volt lighting system.

A four-stage air compressor provides all of the compressed air for the production of oxygen. The air purifier removes the carbon dioxide from the compressor, and the refrigerator group assists in providing the necessary temperatures. The drying and liquefaction of the compressed air with the separation into pure oxygen and nitrogen is accomplished by the air-separator group.

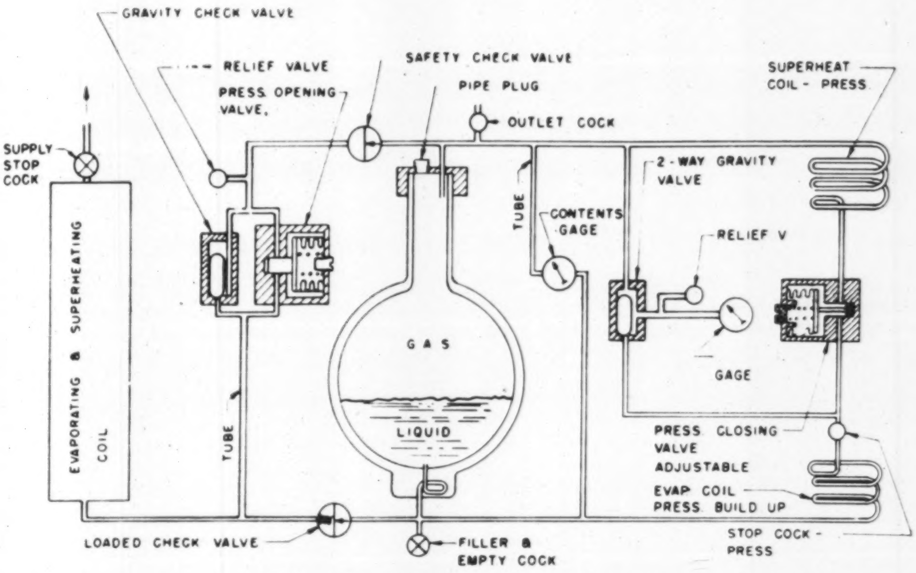


FIG. 6 FLOW DIAGRAM FOR BENDIX CONVERTER

Filling of the storage tanks, whether they are in the airplanes or are the high insulated tanks, is relatively simple. Oxygen supplies then may be flown to remote bases where there is no generating equipment, or may be used in the airplanes ready for flight.

Mineral Exploration

THE use of new mineral exploration techniques by the U. S. Government and industry to provide for future mineral demands is reviewed in the *Industrial Bulletin* of Arthur D. Little, Inc., February, 1949. Intensified conventional geologic search and development of more efficient recovery methods which permit use of lower-grade ores is also being conducted. Considerable success has already been attained. New finds in the Caribbean have outstripped wartime consumption of aluminum ore. That part of the Labrador deposits already proved replaces all of the iron ore taken from the Lake Superior region during the war, while new beneficiation techniques extend present reserves. Iron ore from both these sources will cost more, but not prohibitively. New finds of copper ore plus extensions of previous reserves have kept ahead of consumption although a third of our copper is imported. Zinc resources have stayed about even, while new discoveries of lead have hardly offset the depletion of known districts. The United States is still short of manganese, chromite, and tin, but well supplied with nickel, titanium, molybdenum, mercury, and silver, the article stated.

Most of the last decade's finds were made by traditional methods, and these will continue important, but the newer tools will greatly improve the prospectors' lot. The air-borne magnetometer, one of the new prospecting tools, grew out of wartime research in submarine detection. It measures local changes in the earth's magnetic field caused by a submarine, or, for geologists, by magnetite, which is an indicator mineral for specific conditions that are necessary for the formation of other more valuable minerals. The instrument is used for broad surveys which direct prospectors to likely areas. Prewar surveys were made with the magnetometer on the ground, but making the instrument sensitive enough for airplane use cuts the survey cost, formerly up to $200 or more per linear mile, to $10 to $15. In the Americas and Africa, 500,000 square miles have been surveyed by the air-borne magnetometer; finds include the world's greatest titanium deposit, located in eastern Quebec.

The most important present use of the air-borne magnetometer is in petroleum exploration, where pools are often thousands of feet underground. A recent survey of 85,000 square miles over the sea near the Bahamas used Shoran radar to record the path of the survey plane.

The use of the airplane in exploration has been extended, not only for access to remote areas, but also for use in topographic mapping and in actual search. When the reserves of aluminum ore in this country began to look critically low during the war, an exploration party started out to find bauxite by airplane after geologic reasoning had suggested searching for an elevated plateau with a topography indicating limestone, in a tropical climate, and with red soil. The right combination was found in Haiti and the reserves of bauxite subsequently located restored this country's aluminum resources to a strong position.

Promising results have come from "biogeochemical" prospecting. Some plants concentrate trace metals in their leaves, and thus may indicate mineral deposits beneath their soil. Plants in a British Columbia copper-mining district carry an average of ten times as much copper as those in a neighboring district with no copper deposits; in some species, such as green alder and devil's club, the increase was 50 to 100 times. A similar but less marked relation to zinc deposits has been noted. An investigation of traces of metals in plants, waters, and soils, as a means of prospecting, is now in progress under the direction of the U. S. Geological Survey. This program includes development of simple analytical tests with which a prospector can follow increasing metal concentrations in his search for buried ore deposits.

The most intensive use of new exploration technology is in seeking uranium. The Atomic Energy Commission's bonus of $10,000 for discovery of a new uranium deposit and the increased value of uranium encourage extensive prospecting, especially in Utah and Colorado. Gamma-ray counters to locate deposits may be carried by a man or in jeeps, or even in helicopters. Although gamma radiation is cut in half by passing through two inches of rock, it is often possible to locate uranium several feet under the surface. When the radioactive material is exposed, the radiation may be picked up from several hundred feet above. Specially designed counters are lowered into drill holes to locate underlying strata.

U.S.A.F. Jet Fighters

XF-91

THE U. S. Air Force's jet fighter, the Republic XF-91, started taxi tests recently at Republic's Farmingdale, L. I., N. Y., plant.

The XF-91 is designed as an interceptor fighter to be used as a local defense weapon capable of combating enemy bombers and such missiles that come within its range and capabilities.

Powered by a turbojet engine, the interceptor incorporates rocket motors for accelerated take-off and climb, and for operations at high altitude.

The XF-91's thin wings are swept back and have the appearance of being wider at the wing tips than at the wing and fuselage junction. The horizontal and vertical tail surfaces are also swept back.

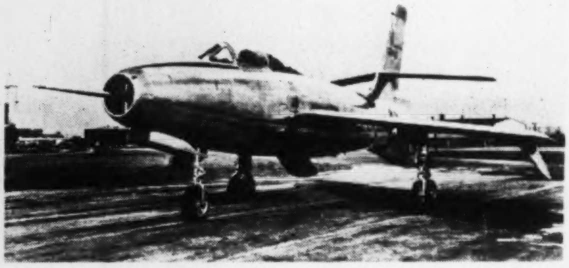


FIG. 7 REPUBLIC XF-91 JET FIGHTER

The wing span of the aircraft is approximately 30 ft and its length over 45 ft. The landing gear is composed of two wheels in tandem under each wing and a conventional nose gear. The XF-91 is equipped with a pilot-ejection seat, cabin pressurization, and refrigeration for the pilot at high speeds.

XF-89

The U. S. Air Force's newest all-weather jet fighter, the Northrop XF-89, has been named "Scorpion" and is undergoing flight tests at Muroc, Calif., Air Force Base where it made its first flight August 16, 1948.

Manufactured by the Northrop Aircraft Corporation at Hawthorne, Calif., the thin-winged XF-89 is specially designed for tactical operations at night or under unfavorable weather conditions. It has a crew of two, a pilot and a radar observer, both of whom can be "exploded" clear of the airplane by pilot-ejection seats if the plane must be abandoned at high speeds.

Powered by two Allison J-35 jet engines, each rated at 4000 lb thrust, the Scorpion is in the 600-mph class.

The XF-89 has a service ceiling of more than 40,000 ft and a design gross weight of more than 30,000 lb. It has a wing span of approximately 50 ft, a length about the same, and is approximately 15 ft high.

The Scorpion's horizontal stabilizer is about halfway up the vertical stabilizer to keep it free from the expelled hot exhaust gases. This location also diminishes the effect upon the stabilizer of the turbulence caused by the air flow over the airplane's wing.

The two turbojet engines with which the fighter is equipped are carried in separate engine nacelles beneath the fuselage. The air intake ducts for these engines are located on either side of the fuselage in front of the leading edge of the wing, and the tail pipes are beneath the fuselage a few inches forward of the trailing edge of the wing.

The thin wing used on the XF-89 was adopted by Northrop in lieu of a sweptback configuration and extra-thick wing skins are used to provide a safe margin of rigidity at high speeds.

F-86

The U. S. Air Force's fastest jet fighter, the North American F-86, has been named "Sabre."

The single-place low-wing fighter established the world's speed record of 670.981 mph at Muroc, Calif., Air Force Base, last September, carrying its normal operational armament and ammunition.

The Sabre has a sweepback of 35 deg for both wing and tail assembly, which reduces drag and increases maximum speed.

Powered by a General Electric J-47 turbojet engine rated at approximately 5000 lb thrust at take-off, the F-86 employs a single straight ram duct which has its opening in the nose.

The Sabre has a service ceiling of over 40,000 ft and a combat radius of more than 500 miles.

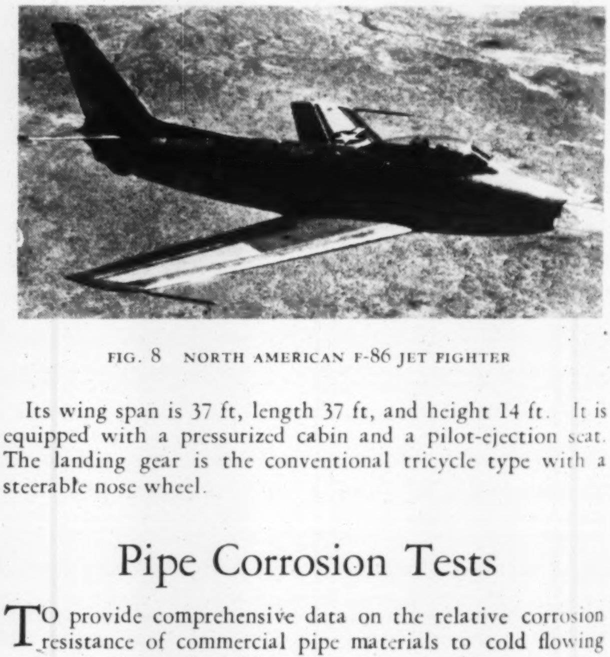


FIG. 8 NORTH AMERICAN F-86 JET FIGHTER

Its wing span is 37 ft, length 37 ft, and height 14 ft. It is equipped with a pressurized cabin and a pilot-ejection seat. The landing gear is the conventional tricycle type with a steerable nose wheel.

Pipe Corrosion Tests

TO provide comprehensive data on the relative corrosion resistance of commercial pipe materials to cold flowing water, continuous-flow laboratory tests extending over a 10-year period have been made on a number of these materials by G. A. Ellinger, L. J. Waldron, and S. B. Marzolf of the National Bureau of Standards. Studies of the data indicate that while there were significant differences in the corrosion of some of the materials, the more expensive pipes offer no appreciable advantage in this respect over the usual cast-iron water pipe.

Tap water of known analysis was circulated at constant velocity through a system of eight vertical columns, each made up of 14 specimens of $5^{1}/_{2}$-in. pipe lengths. The specimens consisted of two types of cast iron, three of wrought iron, two of ingot iron, and three of open-hearth steel. Individual specimens were removed and replaced with new ones of the same materials at the end of specified periods ranging in length up to 10 years. Corrosion of the exposed pipe, as indicated by loss of weight and depth of pits, was then evaluated in relation to duration of exposure.

The test sections were first washed thoroughly in strong alkali or soap solution and treated with 10 per cent sulphuric acid and an additional washing in clean soap solution. Corrosion of exterior surfaces of the pipes was prevented during the tests by coating with asphalt varnish.

The equipment was designed to permit the continuous uniform exposure of the inner surfaces of all of the specimens to water of known composition and constant velocity. Except for the metal specimens, the water within the apparatus came in contact only with rubber, glass, and stainless steel. Turbulence of the water entering the apparatus was prevented by the insertion of a number of parallel glass rods in the top of each column. The columns were supported in a vertical position and maintained in a watertight condition by tie rods, guide and supporting sleeves, and stainless-steel holders. The capacity was about 70 gal.

After removal from the test columns, the specimens were dipped in trichlorethylene to dissolve the varnish. Corrosion products were removed by washing and treatment with 10 per cent sulphuric acid and dilute caustic soda. The specimens were weighed, and the corrosion losses were calculated in grams per unit of interior surface area. The specimens were then sawed longitudinally and the depths of the pits on the corroded surfaces were measured.

It was found that corrosion of the interior surfaces of the pipes started with the formation of small localized mounds of rust, the number and size of which increased with time. The rust which formed during the first year or two was lightly adherent and was easily removed. However, as corrosion continued, the rust coating became denser, more tightly adherent, and more difficult to remove as most of the mounds developed into a tubercular form of rust. Many uncorroded areas were found on the surfaces of the specimens during the first several years of testing, but few were found on specimens exposed for more than five years. The pH of the water was such that small amounts of calcium carbonate were deposited with the rust, probably increasing the protective effects of the rust coating.

Although the results show a certain amount of scatter among the individual specimens, a rather definite trend was established early in the test and continued throughout its life. Materials which showed the highest losses of weight or depth of pits in the early stages generally maintained this trend throughout. With respect to loss of weight, the test materials fall into three groups. Wrought iron—hand-puddled, open-hearth steel, copper-bearing steel, ingot iron, Cu-Mo ingot iron, and nickel-bearing wrought iron had the lowest corrosion losses; somewhat higher losses were experienced by wrought iron—aston process, cast iron—sand-cast, and cast iron—centrifugal-cast; and Cu-Cr-P-Si steel had the highest losses.

The average depths of pits at the end of seven years showed considerably more difference than the average losses of weight. Centrifugally cast iron, nickel-bearing wrought iron, and Cu-Mo ingot iron had the shallowest pits; intermediate pit depths occurred in wrought iron—aston process, open-hearth steel, ingot iron, and copper-bearing steel; and sand cast iron, hand-puddled wrought iron, and Cu-Cr-P-Si steel had the deepest pits.

The shallowest pits occurred in the centrifugally cast iron, while the sand-cast iron had pits approximately twice as deep. Since the loss of weight was about the same for both materials, these results indicate that the corrosion of the centrifugally cast iron was general, with little localized deep pitting, whereas that of the sand-cast iron was largely by deep pitting. The condition of the casting skin of these materials was probably largely responsible for the difference in corrosion characteristics.

Failure of any piping material in actual service usually results from perforation of the wall by pitting, with resultant leakage. It might be expected that the depth of the deepest pit would control the time required for a pipe to pit completely through, but no evidence was found to indicate that the deepest pit at any intermediate stage of the test would be necessarily the first to perforate. On the other hand, some evidence was obtained that pitting might be inhibited at times by the deposition of chemical compounds or by the formation of corrosion products in the bottoms of the pits, thus preventing or retarding subsequent attacks. With the exception of the two cast irons, which had greater wall thicknesses than the wrought materials, the average depths of pits after seven years represented penetrations of from 20 to 40 per cent of the wall thickness, whereas after 10 years the penetrations were from 25 to 26 per cent. If the depths of the deepest pits are used as criteria, the penetration of corrosion into the various materials other than the cast irons ranged between 30 and 70 per cent after seven years of testing. In those tested for ten years, the penetration ranged from 36 to 52 per cent.

Comparison of the average depths of pitting obtained in these tests with those obtained in other tests still under way at the Bureau on actual service lines, indicates that approximately 50 per cent greater corrosion occurred in the laboratory tests than in the service lines. This is probably due to the continuous flow of the water in the laboratory tests as compared with intermittent in the several lines. In the laboratory the corrosion products would tend to be removed more rapidly than in the service lines; thus in the latter the accumulation of corrosion products might be expected to retard the corrosion process to some extent.

The results of the tests indicated that there was no great difference in the rates of corrosion of most of the wrought materials when measured either by loss of weight or by depth of pitting. A low-alloy steel had the highest corrosion rate while a copper-molybdenum ingot iron and a nickel-bearing wrought iron had the lowest rates. Other low-alloy materials such as wrought irons, ingot iron, and ordinary medium carbon-steel pipes corroded at intermediate rates. A rough estimate of the minimum life of these bare materials when subjected to continuous flow of Washington (D. C.) water would be about 15 years on the basis of this work.

Silica-Magnesia Catalyst

MORE gasoline from our national oil reserves was the promise held forth in a paper presented by A. L. Conn, W. F. Meehan, and R. V. Shankland of the Standard Oil Company of Indiana before a recent meeting of the American Institute of Chemical Engineers, in Los Angeles, Calif.

Reporting on the commercial performance of silica-magnesia catalyst, the authors pointed out that this new material, when used in a fluid catalytic-cracking unit in an oil refinery, makes several per cent more gasoline than ordinary catalysts from the same amount of oil.

Only two types of catalysts have been used up to May, 1948, in commercial fluid catalytic-cracking units, it was pointed out. Standard of Indiana's research laboratories, however, have been testing other kinds of catalysts, and have found that synthetic silica-magnesia is the most promising of them.

A catalyst is a material that helps along a chemical reaction without taking part in it itself. When oil vapors are heated very hot they "crack," partly into lighter oils and partly into coke. When a catalyst is put into the hot oil vapor, cracking takes place at lower temperatures, and more gasoline, less coke, is made.

Ten years of experimental work on the new catalyst showed favorable results and full-scale trials were then made in a commercial fluid process cracking plant running one million gal of oil a day.

Higher gasoline yields with somewhat lower octane number were reported with the new catalyst, but the addition of tetraethyl lead practically overcomes this. The new catalyst stays active unusually well and it requires one third less make-up than ordinary catalysts because it is mechanically stronger.

Community Service

IN an address delivered in a panel discussion on "What's Needed in National Water Conservation" before the 14th North American Wild Life Conference in New York on March 8, Morris Llewellyn Cooke, Fellow ASME, of Philadelphia, Pa., deplored the abstention of engineers from politics and community service.

He blames in part, the accepted pattern of undergraduate education in which the engineering and science students are barred from, or bar themselves from, those campus activities and relationships which would develop their interest in political organizations, legislative assemblies, and various pressure groups. Also at fault is the engineer's status as an employee to an employer who frequently discourages activities outside the "company." Whatever the cause, the engineer traditionally scorns politics and government work, to the detriment of the nation as a whole.

There is a specific need for a national engineering policy with regard to water conservation, he said. The national movement of soil conservation, which embraces water conservation, gets a minimum of support from water engineers.

In the matter of stream pollution there appear to be more engineers facilitating this growing disgrace than are to be found in the ranks of those opposing further degradation of our rivers. The statement has been responsibly made, that water engineers are divided about 50-50 between those who think rivers are natural sewers and those who oppose their defilement.

Our underground water reserves are decreasing and will have a catastrophic effect on agriculture and industry and yet the voice of engineering is all but unheard. Little is known about the natural replenishing of ground waters, except for the rather obvious assumption that the more rain water is allowed to percolate through the soil rather than permitted to run off, the better for our reserves. Engineers as a professional group should promote research on this problem through public and private financing.

In these times of multiplying interests, only aggressive pressure brings results. Engineers must utulize every opportunity for serving the lay public with their training and their specialized knowledge.

Cold-Weather Testing

SPECIALLY designed insulated clothing and intricate instruments have been tested successfully for the U. S. Air Force in temperatures ranging to 40 deg below zero by University of Washington scientists for Arctic research.

The experiments were conducted by the University in the first phase of a two-year research project for the Air Surgeon's office of the U. S. Air Force.

Information gathered during a one-month midwinter expedition to Alaska is now being analyzed by a University research group to determine the effects of Arctic temperatures on the human mind and body. The primary purpose of the trip was to determine if field tests in subzero temperatures could be made on a full-scale laboratory basis.

The insulated clothing, equipped with wires and tubes to check body heat loss at various points, was made to order for the tests. These wires and tubes were connected with instruments carried in a mobile laboratory in a larger trailer.

An intricate mask, also designed on the campus, provided separate measurements for the temperatures of inhaled and exhaled air.

The instruments in the trailer were similar to the panels of an engine test stand used for checking performance of motors. But in the University experiments, the human body was tested instead of a machine.

Members of the expedition served as their own "guinea pigs" for most of the tests. In one experiment 20 airmen from Ladd Air Force Base, Fairbanks, Alaska, co-operated in the measurement of heat output and oxygen intake before and after a seven-mile hike through the snow.

The instruments enabled the scientists to chart the actual combined effects on the body of air temperature, wind velocity, and radiation from the sun.

One of the results indicated by the work, it was stated, is that the heat loss by inhaling subzero air is not as large as expected. It was found, too, that even the radiation from the weak midwinter Alaskan sun had a marked effect on reducing body heat loss.

Stainless Skull Templates

AN interesting and important development in the field of medicine and surgery, reported in *Nickel Topics*, March, 1949, is the production of prefabricated templates of stainless chromium-nickel steel for skull-injury repairs. Many people, as the result of war wounds or accidents, have had part of their skull bone structures replaced by silver plates. Other costly or rare materials, such as tantalum, have also been successfully used in head surgery. Now stainless steel enters the picture prominently, the article reveals.

Uza Nudell, of New York, N. Y., who has specialized in special and difficult metal-fabricating jobs for some 25 years, supplies "semifinished" skull templates in eight standard sizes. Mostly elliptical in shape and graduated in curvature according to size, these stainless-steel plates measure from $2\,^1/_2 \times 2\,^1/_4$ in. to $5\,^1/_2 \times 4$ in. Until recently, neurosurgeons have had to fabric skull plates "on the job." With the patient under anesthesia, the doctor had to cut out and form the metal needed to repair the injury while standing by the operating table. Now, if the hospital had ready a set of these standard templates, saving of valuable time and a much higher rate of complete recovery can be anticipated in emergency cases. (Where a head injury is at the lower portions of the skull in which the surface contour is irregular or where a facial bone is involved special templates must of course be made.)

The first step in making a special template is to prepare a plaster mold of the patient's head and/or face, and the depressed contours caused by the injury are duplicated in the mold and built up with wax. The combined wax-plaster mold is then used to make a new mold of a harder material, which is used to produce dies which, used in a hydraulic press, give the initial curvature of the template. The sheet is then hammered to the exact contours of the die, its edges trimmed, and the holes and slots punched.

The round holes around the edges are for screws, which like the templates proper, are made of Type 302 (18-8) chromium-nickel stainless steel. Where wire is to be used, it is of the same material. The stainless-steel sheet 0.015 in. in thickness, possesses rigidity equal to that of the bone it replaces and has proved to be unaffected by body fluids or tissues.

ASME TECHNICAL DIGEST

Substance in Brief of Papers Presented at ASME Meetings

Petroleum Mechanical Engineering

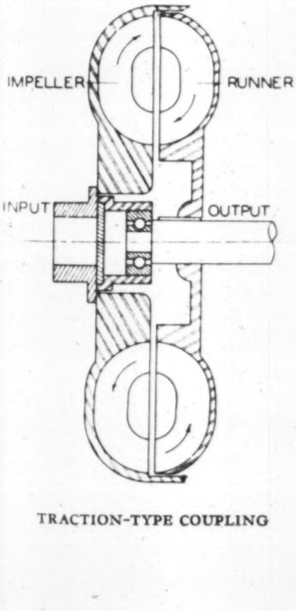
Hydraulic Torque Converters and Fluid Couplings for Oil-Field Machinery, by H. A. Davis, Twin Disc Clutch Company, Dallas, Texas. 1948 ASME Petroleum Division Conference paper No. **48—PET-24** (mimeographed).

Designers of modern oil-field equipment have come to realize that the proper application of hydraulic-drive units extends the capacity, improves the performance, and increases the wear life of the basic machine, and with this realization has come a tremendous increase in the number of installations.

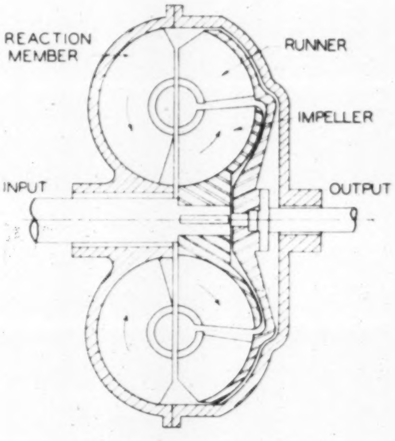
This paper describes oil-field applications of various designs of hydraulic units.

Fundamentally, there are two distinct divisions of hydraulic drives, namely, the positive-displacement or hydrostatic unit depending upon fluid pressure to transmit the power, and the turbo or hydrokinetic unit depending upon fluid velocity to transmit the power. This paper is confined to the turbo type of unit in its various forms.

The hydraulic coupling and the torque converter are the two fundamental forms of the turbo or the hydrokinetic drive units. Both depend upon the ability of fluid to absorb and then release kinetic energy in the form of increased and decreased velocity. The fluid circuits of both couplings and converters are annular or "doughnut-shaped" chambers, because in such forms the circuits have greatest compactness and lowest fluid frictional losses.



TRACTION-TYPE COUPLING



SINGLE-STATE CONVERTER

The coupling has but two principal parts, the impeller and the runner, while the converter has three principal parts, the centrifugal pump, the turbine, and the reaction member which is attached to the housing. In both units, the impeller, or pump, picks up the fluid at the center and imparts to it kinetic energy in the form of increased velocity as it travels outward radially. The fluid then passes through the runner or turbine, as the case may be, giving up its velocity or energy as it returns inward radially. In the case of the coupling, this kinetic energy is transmitted as unit torque with frictional losses becoming evident as slip or lower output speed. The converter fluid circuit differs at this point from the coupling in that the fluid upon leaving the turbine blades then passes through the reaction-member blades which changes its direction of flow. Since the reaction blades are stationary and are attached to the housing, the resulting torque force due to redirection of the fluid is actually added to the input torque, resulting in an increased output torque; for as is well known, in a balanced system, input and output torque forces must total zero.

The performance characteristics of the various types and modifications of these basic units are discussed.

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Factors Influencing the Economic Design of Pressure Vessels, by G. E. Fratcher, Mem. ASME, A. O. Smith Corporation, Milwaukee, Wis. 1948 ASME Petroleum Division Conference paper No. **48—PET-25** (mimeographed).

The design of pressure vessels involves knowledge of engineering, safety codes, materials, and types of construction. There are many combinations that will produce a satisfactory vessel, but the cost and weight can vary 30 to 40 per cent, depending upon the design employed. In this paper some specific examples of different designs are given in an endeavor to illustrate this.

The design of unfired pressure vessels has several fields in which the manufacturer can assist. First, the field can be arbitrarily established as low pressure up to 300 psi, high pressure up to 2500 psi, and extremely high pressure above 2500 psi. Second, it can be classified as low temperatures up to 650 F, high temperatures above 650 F, and subzero below minus 20 F. Third, it can be considered as to materials, namely carbon steels, low alloys, high alloys, nonferrous, and composite materials. Each of these fields is interrelated and are all part of process design. Welded fabrication of pressure vessels only is considered in this paper.

In the low and high-pressure field, the designer is confronted with the selection of materials and the requirements of x-ray examination or stress relieving to achieve an economical design. To illustrate variances in design affecting economy of a vessel, the author has selected a simple vessel 100 in. ID × 30 ft, tangent to tangent length, with 2:1 ellipsoidal heads, a 16-in-diam manway and several connections ranging from 4 to 10 in. in size. The design conditions consist of a pressure of 275 psi and a temperature of 150 F, and the specifications leave stress relieving and x ray to an economical consideration and to meeting Code requirements. Corrosion allowance is not required.

Since the vessel is for refinery service, it may be designed to meet the requirements of the API-ASME Code, the ASME Code, or both.

Oil-Field Boilers, Performance and Construction, by S. Mensonides, Mem. ASME, Farrar & Trefts, Inc., Buffalo, N. Y. 1948 ASME Petroleum Division Conference paper No. **48—PET-27** (mimeographed).

To generate steam for the operation of drilling equipment, the locomotive-type boiler has been a favorite since the earliest days. Other types of boilers have been introduced but so far with little success. It is true that the locomotive-type boiler is not the most efficient steam generator but it has distinct advantages that count in the particular needs of oil-field use. It is a self-contained unit that can be set up quickly and moved from one location to the next one with relative ease. It produces steam rather fast and in good steadfast volume and the steam output can be stepped up rapidly for intermittent peak loads. Even on semistationary installations, such as on drilling barges, the locomotive-type boiler is practically always selected for the most modern steam rigs.

Figures from the Bureau of Census and other sources indicate that during the last three years some 800 new boilers of this type have been built and sold. Over 90 per cent of these were of the so-called 150-hp size. During the war this size boiler was adopted by the Petroleum Administrator for War as the standard oil-field boiler, and it is now generally accepted as such. This 150-hp is a minimum manufacturers' rating, based on the old standard of 1 boiler hp for every 10 sq ft of heating surface. It is a well-known fact that this rating is very conservative. On the basis of actual or potential output this size boiler might well be rated around 400 hp or more.

This paper outlines a history of developments in the use of these boilers and their construction, also shop procedures on fusion-welded boilers.

Gasoline and Refinery Instrumentation—Better Practice Guides, by J. M. Ribble, Phillips Petroleum Company, Bartlesville, Okla. 1948 ASME Petroleum Division Conference paper No. **48—PET-28** (mimeographed).

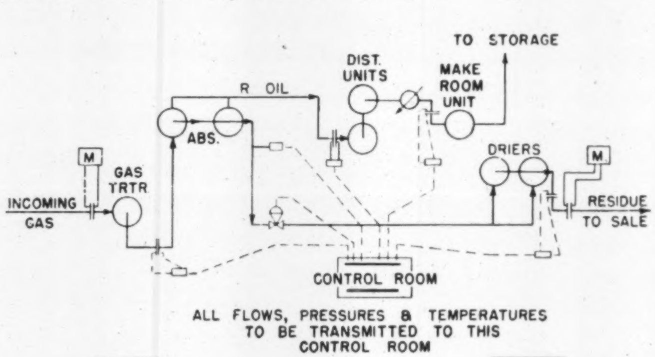
The factors affecting instrumentation in refinery-type plants, while analogous to those encountered in a typical gasoline plant are yet somewhat different, being in the main much more complex because of the necessity of measuring and controlling various materials at elevated temperatures and pressures, generally with corrosive fluid flows present. This means that the instruments must be more exact in design, more selective as to type, and more thought given to their installation. To these inherent problems must be added those of operational practice. When control equipment is concentrated within special control rooms for more convenient use, it necessitates lengthy connecting lines from temperature or pressure point to the control instrument. These long lines create many problems due to the tendency of the hydrocarbons to plug the connecting lines, of entrained water to freeze, and in extreme cases, of corrosive fluids in the connecting lines to cause material failure with resultant fire and explosion hazards.

During recent years, through the development of pneumatic transmission from experimental stage to practical use, many of these problems have been solved. As newer plants are built and instrumentation design draws freely on the newer-type measurement and control equipment, complete installations will be possible which will more nearly assure continuous trouble-free instrument operation regardless of fluid or weather conditions.

This paper shows some of the problems encountered in gasoline and refinery-type plant instrumentation and offers some practices involving specifications, installation, and operation tending to make plant operation more nearly automatic and more trouble-free than in the past. The material has been prepared covering gasoline-plant operation and refinery-type plant operation, since in the gasoline department, the development of the latter plant has followed years of experience in the manufacture of gasoline with the many special products recently developed from natural gasoline and gas being an easy step through the adaptation of the gasoline-plant facilities to the manufacture of the more unique products.

Let's Talk About Meters, by M. L. Barrett, Jr., Shell Oil Company, Inc., East Chicago, Ind. 1948 ASME Petroleum Division Conference paper No. **48—PET-23** (mimeographed).

Meters are precision-made mechanical instruments which require periodic attention and inspection. They must have intelligent handling, adequate proofs, careful operation, and attention to all the technical details which affect their performance before they will produce the high type of measurement of which they are capable. Cognizance must be taken

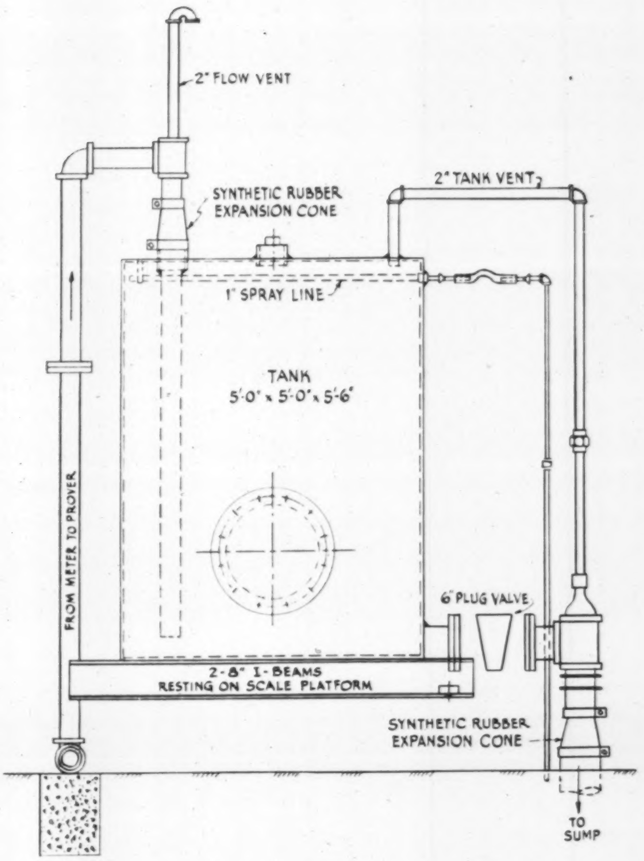


GENERALIZED EQUIPMENT LOCATION FOR INSTRUMENTS by their operators of their proved operating characteristics and of the technical and physical features affecting their appurtenances and proving systems and ultimately affecting their over-all measurement.

The most important factors, all of which must be given primary consideration in order to get the most out of meters, include the following: (1) Volumetric provers must be carefully designed and calibrated and maintained in calibration; (2) dirt, scale, gas, and water must be eliminated from the measured stream; (3) flow rates must be maintained to produce meter accuracies within the desired tolerances; (4) meter wear must be counteracted by sufficiently frequent repairs and proofs to enable the meter to stay within the desired tolerances; (5) varying the type of liquid measured will vary the meter accuracy; (6) meter proofs must identically simulate normal meter operating conditions; (7) temperature changes cause physical changes in the meter, the metered liquid, and the volumetric prover, and necessitate adequate and careful consideration. Temperature compensators are not recommended in precision measurement; (8) changes in pressure inside an operating-meter's case changes its accuracy, making it advisable to meter at constant low pressures; (9) the frequency of meter proofs should be determined by field experience and should be such that the meter will always measure within the desired tolerances; and (10) the skill acquired through specialized training and experience with meters in the field is essential to smooth operation and good measurement.

Positive-displacement meters are doing an economical and accurate job of measurement in many branches of the oil industry. Judging from the past few years' experience, and from their rapid acceptance, they can be counted on to do this job still more accurately and economically in years to come. Operating and proving techniques which properly handle and account for the variables discussed have been established and tentative standards adopted for the entire industry.

Gravimetric Proving of Liquid Meters, by Joseph B. Smith, Cleveland, Ohio. 1948 ASME Petroleum Division Conference paper No. 48—**PET-30** (mimeographed).


2" FLOW VENT
2" TANK VENT
SYNTHETIC RUBBER EXPANSION CONE
1" SPRAY LINE
TANK 5'-0" x 5'-0" x 5'-6"
FROM METER TO PROVER
6" PLUG VALVE
2-8" I-BEAMS RESTING ON SCALE PLATFORM
SYNTHETIC RUBBER EXPANSION CONE
TO SUMP

GRAVIMETRIC PROVER TANK

Gravimetric meter proving involves the careful comparison of a quantity of liquid as measured by a meter with the same quantity as weighed by scales. The comparison may be made by flowing the liquid through the meter into a tank resting on scales. The volume as registered by the meter may then be converted into weight so that it can be compared with the registration of the scales; or the scale weight may be converted into volume and then it can be compared with the meter reading.

Volumetric meter proving involves the careful comparison of a volume as measured by a meter with a volume as measured by a tank, or by another meter. One extra step then is required by the gravimetric or weigh method which is not necessary when meters are proved volumetrically. This extra step, volume-to-weight or weight-to-volume conversion, has no doubt caused volumetric meter proving to be used even in applications for which it is not well suited.

In some instances gravimetric meter proving has certain advantages that outweigh the inconvenience of making the conversion and for such cases it should be selected. The following three cases are examples:

1 Where a comparatively heavy viscous oil is being metered there will probably be sufficient clingage to the inside of a volumetric prover tank to create considerable inaccuracy. Also sight gage glasses are very difficult to keep clean and read accurately with this type of oil.

2 Oils containing waxes that tend to deposit out or any liquid-carrying materials that may precipitate in the prover tank will render volumetric proving inaccurate if a constant check is not made to insure against deposits accumulating and affecting the accuracy of the volumetric tank readings.

3 Highly volatile liquids with high vapor pressures are difficult to handle with volumetric proving as pressures and temperatures must be kept constant for accurate readings or else corrections must be made for pressure and temperature variations. With gravimetric proving both of these variables can be handled without the necessity of correction, since changes in pressure and temperature have no effect on the weight of a quantity of liquid.

It is probably correct to state that meters handling liquids such as crude oil, heavy fuel oils, or liquefied petroleum gases can be more conveniently and accurately proved by the gravimetric method. This paper discusses methods and equipment for applying gravimetric proving to meters handling oils of these three types.

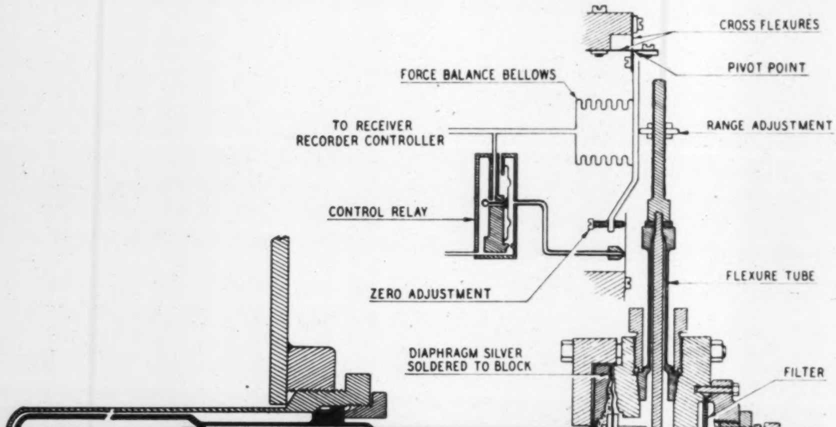
Automatic Control of Fractionating Columns, by V. V. St.L. Tivy, The Foxboro Company, Foxboro, Mass. 1948 ASME Petroleum Division Conference paper No. **48—PET-31** (mimeographed).

The increased demand for high-octane gasolines has resulted in the need for more exact separation of hydrocarbons in fractionating columns with a consequent desire for improved automatic control. The paper discusses the reasoning which should be followed in the application of automatic controllers, and emphasis is laid on the necessity for close integration between plant design and automatic-control engineering. A number of typical control systems are discussed, culminating in the suggestion of a new method for control of precise fractionators.

The function of instruments in a refinery may be broken down into two categories. One group covers instruments which are used for providing an indication of a process condition or a record of that condition for the guidance of operators and for statistical reasons. The selection and application of these instruments should be determined largely by the personnel who will be operating the equipment in order that they will be provided with as much information as is necessary for operation of the units in accordance with their standard practices.

The second group covers instruments used for automatic control of the process. Continuing changes in process requirements and in development of automatic-control equipment make desirable a review of the engineering involved in application of these controllers.

In order to obtain the most effective use of automatic control, the equipment must be applied with a better understanding of the process itself with particular reference to the end product required, the effect upon the process of manipulation of valves, and also complete understanding of the limitations and capabilities of automatic controllers. It is desirable that the physical design of processing equipment be carried on concurrently with the design of the automatic-control system particularly as it is often found that the engineering details of one affect the other.


CROSS FLEXURES
PIVOT POINT
FORCE BALANCE BELLOWS
TO RECEIVER RECORDER CONTROLLER
RANGE ADJUSTMENT
CONTROL RELAY
FLEXURE TUBE
ZERO ADJUSTMENT
DIAPHRAGM SILVER SOLDERED TO BLOCK
FILTER
LIQUID IN BULB SAME AS LIQUID ON TRAY
BOTH CONNECTIONS AT SAME ELEVATION
VAPOR PRESSURE OF LIQUID IN BULB
VAPOR PRESSURE OF LIQUID ON TRAY
CONTROLLED TRAY

DIFFERENTIAL VAPOR-PRESSURE TRANSMITTER

(A simple force-balance system is used to measure the force exerted upon the diaphragm by the difference in the two vapor pressures, and the instrument is arranged so that zero differential is read at the center of the chart where the control point is set. A pen movement up scale indicates an increase in the lighter component on the tray, while a downward pen movement indicates the reverse.)

Notes on the Uses of Stainless Steels in the Petroleum Industry, by Paul L. Weinman, Armco Steel Corporation, Tulsa, Okla. 1948 ASME Petroleum Division Conference paper No. **48—PET-33** (mimeographed).

In 1934 the stainless-steel industry produced about 56,000 ingot tons. In 1947 more than half a million tons of stainless-steel ingots found their way into a variety of domestic, industrial, and commercial uses. Thousands of tons went to oil fields, refineries, natural-gasoline and carbon-black plants, for example.

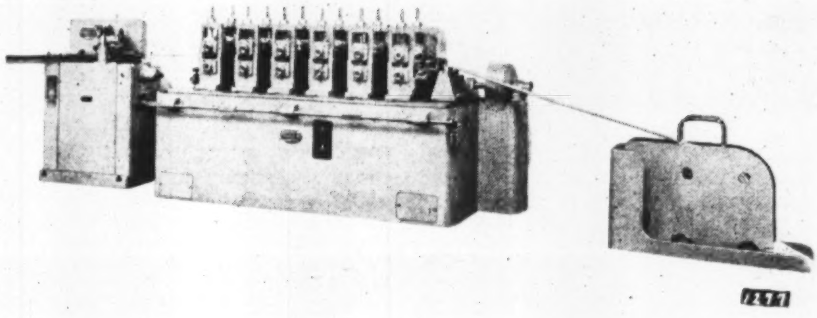
Actually, any corrosion-resisting steel is called stainless if it contains at least 12 per cent chromium. However, this is only one of 30 different standard analyses of stainless steels currently listed by the American Iron and Steel Institute. There are over 100 different compositions which have been and are being tested and used, even though they have not been assigned specific AISI type numbers. About 65 per cent of the total stainless steel produced today is furnished in chromi[illegible] analyses. The other 35 per c[illegible]romium steels containing varying amounts of 12 per cent or more of chromium with either no nickel or only a very small amount of nickel. No one of these grades will work satisfactorily for all applications or stand up under all types of corrosive media. In fact, there are some environments in which no grade of stainless will stand up. Like all other metals and materials, each grade has its limitations.

The petroleum industry probably requires a greater variety of stainless-steel grades or types than any other single large user. From the well, where casingheads are made of Type 410 (12 per cent chromium), to the refinery, where relief-valve parts are made of Type 316 (18 per cent chromium, 12 per cent nickel, 2 per cent moly), gas and oil and all the many by-products of each, come in contact somewhere along the line with practically every grade of stainless steel yet developed. In the petroleum market is likewise found practically every shape, size, and thickness of stainless produced today, from heavy plates in all types of vessels to 0.001-in-thick strip for diaphragms in measuring devices; from large forged valve bodies to 0.066-in round measuring lines; from angles used as structural members in refinery equipment to tubing used in heat exchangers.

The use of stainless steel in gas condensate wells, for well-head equipment, tubing hangers, flange-ring gaskets, measuring lines, various gage wires, towers, and the like, are discussed.

Cold-Roll Forming

Cold-Roll Forming of Sheet and Strip, by E. J. Vanderploeg, The Yoder Company, Cleveland, Ohio. 1949 ASME Spring Meeting paper No. **49—S-3** (mimeographed).



COLD-ROLL-FORMING MACHINE FOR LIGHT SHAPES

Cold roll forming is the process of continuous longitudinal shaping, without heat, of a ductile sheet or strip by means of a series of rolls. The length of the formed shapes is limited only by the length of the sheet or strip being processed. A large percentage is formed from coiled stock and cut to the desired lengths in a flying type of cut-off machine. The intricacy of the shape as well as the quality of metal used determines the number of roll passes necessary to form it.

Modern roll-forming machines are built generally in the two following types: (1) With overhung spindles, referred to as an overhung spindle machine; and (2) with spindles supported at both ends, known as an inboard machine. The overhung spindle machine is suited for forming small shapes of light-gage material. It also reduces the time required to change the tooling (rolls) for producing different shapes, and is therefore well adapted for rolling shapes. The inboard machine is more commonly used than the overhung machine. It has a capacity for much wider sheets or strips and heavier gages, and it maintains its adjustments to a greater degree of accuracy.

Because of its high-production capacity, the uniformity of profiles, and the closely held tolerances in the dimensions of the products, roll forming has been extensively used for many years in the automotive industry. The demand for high production of sheet-metal parts in the aircraft industry during the recent war and the postwar demand for metal products of all kinds, has made cold roll forming a major factor in meeting this demand. In the building industry, cold-roll-formed shapes are being used in many places instead of wood. Siding, studding, joists, sash, doors, downspouts, eaves trough, storm sash and screens, awnings, conduit, lighting fixtures, and other items are being made from cold-roll-formed parts. Complete buildings are being prefabricated from metal, most of the parts being cold-roll formed.

Practically all of the exterior and much of the interior covering on railroad passenger coaches are produced on these machines. Metal flooring and some of the structural parts of freight cars are cold-roll-formed. Frames and coverings on trailers of all types, interior partitions in boats, and many aircraft shapes, are being produced by the roll-forming process.

This paper describes the various types of cold-roll-forming machines. Accessory equipment is briefly discussed and the design and manufacture of the rolls is described. Operation of the cold-roll-forming machines and production is outlined.

Applied Mechanics

THE following papers are to be presented at the National Meeting of the ASME Applied Mechanics Division, Ann Arbor, Mich., June 13–15, 1949. Advance copies of these papers are now available and may be purchased from ASME Publication-Sales Department, 29 West 39th Street, New York 18, N. Y.

On Vibrations of a Two-Bar Elastic System With a Small Rise, by S. Woinowsky-Krieger, Frankfort-on-Main, Germany. 1949 ASME Applied Mechanics Division Meeting paper No. **49—APM-1** (in type; to be published in the *Journal of Applied Mechanics*).

This paper treats the problem of the transverse vibration of a three-hinged system of elastic bars with a small ratio of rise to span. Owing to a nonlinear relation between the acting forces and the deflection, two strictly distinct types of vibration, with an intermediate limiting case of vanishing frequency, can be stated. The problem of elastic stability of the system in the case of a load applied suddenly is also discussed. The system treated is the simplest one in a class of systems, whose elastic stability under statical loads has been investigated in some detail, but whose dynamical properties are still known only very incompletely.

The Effect of an Axial Force on the Vibration of Hinged Bars, by S. Woinowsky-Krieger, Frankfort-on-Main, Germany. 1949 ASME Applied Mechanics Division Meeting paper No. **49—APM-2** (in type; to be published in the *Journal of Applied Mechanics*).

It can be shown that the vibration of an extensible bar, carrying no transverse load and having the ends fixed at the supports, causes an axial tensile force with a period equal to the half-period of the vibration of the bar. This force modifies the process of the vibration to a nonlinear one and produces an increase of the frequency of vibration according to the increase of the amplitude.

On Torsion of Plastic Bars, by P. G. Hodge, Jr., Brown University, Providence, R. I. 1949 ASME Applied Mechanics Division Meeting paper No. **49—APM-3** (in type; to be published in the *Journal of Applied Mechanics*).

This paper is concerned with two aspects of the problem of plastic torsion which do not seem to have received much attention so far. An approximate formula for the warping under large angles of twist is derived and certain conclusions concerning repeated loadings are established.

Determination of the Buckling Load for Columns of Variable Stiffness, by C. C. Miesse, Battelle Memorial Institute, Columbus, Ohio. 1949 ASME Applied Mechanics Division Meeting paper No. **49—APM-4** (in type; to be published in the *Journal of Applied Mechanics*).

A method is given for determining both upper and lower bounds on the critical or buckling load for variable-section columns with axial loading. This method, which is an extension of the Rayleigh principle, is illustrated by three examples.

Relation of Experiments to Mathematical Theories of Plasticity, by D. C. Drucker, Jun. ASME, Brown University, Providence, R. I. 1949 ASME Applied Mechanics Division Meeting paper No. **49—APM-5** (in type; to be published in the *Journal of Applied Mechanics*).

Several classes of mathematical theories of plasticity for work-hardening materials are surveyed and their advantages, disadvantages, and agreement with experiment discussed. Consideration is given to the proper correlation of tests on thin-walled tubes subjected to tension, torsion, and internal pressure in fixed but arbitrary ratio. The continuing debate between octahedral-shearing-stress and maximum-shearing-stress criteria of plastic deformation is re-examined and the more general alternatives are restated. Through an analysis of Osgood's experimental results, it is made apparent that the more general point of view is required for the best correlation. A series of experiments are outlined which make the distinction between the various criteria of loading or deformation very large instead of just a few per cent as in previous work. In the evaluation of present mathematical theories it is shown that incremental-strain theories avoid obvious drawbacks of the so-called deformation type of theory. The concept of isotropic work hardening, assumed in practically all stress-strain relations, is explored and generalized. Strong limitations indicated by the Bauschinger effect, which cannot appear properly in such theories, are pointed out.

Bending Vibration of a Rotating Blade Vibrating in the Plane of Rotation, by R. L. Sutherland, State University of Iowa, Iowa City, Iowa. 1949 ASME Applied Mechanics Division Meeting paper No. **49—APM-6** (in type; to be published in the *Journal of Applied Mechanics*).

An analysis is developed for the uncoupled bending vibration of a rotating blade which is vibrating in the plane of rotation. The numerical method used permits the determination of any mode of vibration by a series of tabular calculations. Expressions are found for relative amplitudes of deflection, moment, and shear along the blade. A wedge-shaped steel blade is taken as an example, and the natural frequency and relative amplitudes of deflections, moments, and shears are found for: (*a*) nonrotating vibration; (*b*) vibration perpendicular to the plane of rotation; and (*c*) vibration in the plane of rotation, using for (*a*) and (*b*) the analysis developed by N. O. Myklestad.

Biaxial Tension-Tension Fatigue Strengths of Metals, by Joseph Marin, Mem. ASME, The Pennsylvania State College, State College, Pa. 1949 ASME Applied Mechanics Division Meeting paper No. **49—APM-7** (in type; to be published in the *Journal of Applied Mechanics*).

This paper describes a new fatigue-testing machine for the application of tension-tension biaxial stresses and presents the result of an investigation on the biaxial fatigue strength of Alcoa 24S-T. The influence of various ratios of the maximum values of the principal stresses upon the fatigue strength was determined. Fluctuating biaxial tensile stresses were produced by subjecting a thin-walled tubular specimen to a pulsating internal pressure and a pulsating axial load. The maximum and minimum values of the principal stresses were kept in phase. Fatigue strengths and S-N diagrams for four principal stress ratios were obtained.

Discontinuities of Stress in Plane Plastic Flow, by Alice Winzer and G. F. Carrier, Jun. ASME, Brown University, Providence, R. I. 1949 ASME Applied Mechanics Division Meeting paper No. **49—APM-8** (in type; to be published in the *Journal of Applied Mechanics*).

This paper presents a method of discussing the stress distribution in the neighborhood of a surface of discontinuity of stress in a field of plane plastic flow. The plastic material under consideration is supposed to obey the laws of the Saint Venant - Mises theory; the surface of discontinuity is assumed to be plane, but the intensity of the discontinuity is allowed to vary along the trace of this plane in the plane of flow.

Impact of a Mass on a Column, by W. H. Hoppmann, 2nd, Mem. ASME, Johns Hopkins University, Baltimore, Md. 1949 ASME Applied Mechanics Division Meeting paper No. **49—APM-9** (in type; to be published in the *Journal of Applied Mechanics*).

In this paper a study is made of the problem of the transverse impact of a mass on a column with simply supported ends. Consideration is also given to the case in which the column has elastic support throughout its length. Formulas are obtained for the deflections and strains. Numerical examples illustrating the theory are worked out in detail.

A Matrix Method of Calculating Propeller-Blade Moments and Deflections, by R. Plunkett, The Rice Institute, Houston, Tex. 1949 ASME Applied Mechanics Division Meeting paper No. **49—APM-11** (in type; to be published in the *Journal of Applied Mechanics*).

A new method is demonstrated for finding the bending moments and deflections of a twisted cantilever beam due to both transverse and axial loads. The actual physical system is approximated by a lumped or discrete system which is handled by matrix methods. It is shown that good accuracy may be expected even with slide-rule computation, since the method corresponds to a set of successive numerical integrations. The setup is particularly adapted to investigating the effects of changing the initial offset and of different rotating speeds of a propeller or turbine blade. In addition, a procedure is demonstrated for the application of a successive approximation method, analogous to a Stodola solution, to a problem which would otherwise show oscillating divergent results.

ASME Transactions for April, 1949

THE April, 1949, issue of the Transactions of the ASME contains the following:

Thermal Environment of Railroad Passenger Cars, K. A. Browne and S. G. Guins (48—SA-45)

Visual Passenger Comfort, Brooks Stevens (48—SA-46)

Railroad Passenger Comfort—Decibel Level, W. A. Jack (48—SA-47)

Truck Riding Comfort, K. F. Nystrom (48—SA-48)

Railroad Passenger-Car Comfort—Discussion

A New Approach to the Design of Dynamically Loaded Extension and Compression Springs, C. I. Johnson (48—SA-23)

Centrifugal Blowers for Two-Cycle Diesel Engines, Robert Cramer, Jr. (48—OGP-2)

Improved Techniques in the Study of Engine Firing Orders Using the Vectorscope, G. J. Dashefsky (48—OGP-1)

Distribution of Heat Generated in Drilling, A. O. Schmidt and J. R. Roubik (48—SA-10)

Thermal Contact Resistance of Laminated and Machined Joints, A. W. Brunot and F. F. Buckland (48—SA-27)

Thermal Resistance Measurements of Joints Formed Between Stationary Metal Surfaces, N. D. Weills and E. A. Ryder (48—SA-43)

Cavitation Characteristics and Infinite-Aspect-Ratio Characteristics of a Hydrofoil Section, J. W. Daily (48—SA-30)

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

Scientists in Uniform

Scientists in Uniform, World War II: A Report to the Deputy Director for Research and Development, Logistics Division, General Staff, U. S. Army. Dr. D. M. Delo directed the survey. U. S. Printing Office, Washington, D. C., 1948. Paper, $5^3/_4 \times 9$ in., ix and 98 pp.

Reviewed by Donald B. Prentice[1]

THIS publication from the U. S. Government Printing Office "presents an analysis of the utilization of 15,000 scientists (and engineers) who were members of the Armed Forces during World War II. It is based on a survey made possible through the co-operation of a number of scientific and engineering societies."

"Science and scientists are vitally important to modern military functions. Success in any future war will depend as much on the effective use of all the scientific resources of the Nation as upon efficient industrial mobilization or skillful command of the fighting forces."

The foregoing quotations are from the foreword of the report and are signed by Major General McAuliffe, Deputy Director for Research and Development, Logistics Division. General McAuliffe might have added that the three factors for success are not only equally important but equally essential. Success based on any two without the third is inconceivable.

As most military men knew, and many civilians suspected, the use of scientific and engineering ability in World War II was not one hundred per cent effective. General McAuliffe frankly recognizes this condition in his closing sentence. "Above all, they (the results of the survey) call for realistic and constructive action within the Military Establishment."

Before judging the value of the survey the reader must reach some conclusion on the reliability of evidence secured by questionnaires sent to participants in the war which asked for their own appraisal of the effectiveness with which their personal skills were utilized. Those who were disgruntled and those who were conceited may or may not have been balanced by the modest and loyal individuals who were thankful and enthusiastic about any opportunity to serve. The reviewer is inclined to accept a balance and to judge the percentages of replies to be reliable as recorded.

Approximately 135,000 questionnaires were distributed to members of national scientific and engineering societies; 69,350 were returned and 15,157 reported military experience. The totals are large enough to be statistically significant. More than 21 per cent and less than 30 per cent entered military service in each of four ways: direct commission, reserve, draft, and enlistment. It is to be expected that those who entered service by direct commission would report the most satisfactory use of their talents. Surely a scientist or an engineer would apply for, or accept, a commission only if he felt that it would lead to a position of service in his speciality. However, 22.7 per cent of this group reported little or no use of their skills and many more, 18.3 per cent, found opportunity to exercise only secondary or collateral training and experience. Corresponding percentages of misplacement for scientists entering the service by draft and by voluntary enlistment were 48.1 and 44.2, respectively. Adding the percentages for these groups of members used far below their possible effectiveness brings the totals to 65 and 63.4 per cent. In other words, only one third of the scientists and engineers entering military service by draft or voluntary enlistment contributed their primary skills at proper levels, for half or more of the duration of their military experience.

Many pages of the report are devoted to analyses of military usage of scientific skills by branch of science or engineering, by extent of education, and by kind of work done. All of these support in varying degree the conclusions summarized herein.

It is not surprising that Gen. McAuliffe asks for a thorough review of procedure and a strenuous effort to prevent repetition should another emergency arise.

The pamphlet is an indirect tribute to the American scientist, for in spite of misassignments a remarkable job was accomplished and without personal resentments leading to noticeable obstructionism.

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[1] Director, Scientific Research Society of America, New Haven, Conn. Fellow ASME.

Design for Welding

Design for Welding. Robert S. Green, Editor. James F. Lincoln Arc Welding Foundation, Cleveland, Ohio, 1948. Semiflexible simulated-leather covers, $5^3/_4 \times 8^3/_4$ in., tables, figs., illus., xxx and 1024 pp., \$2, postage prepaid in the U. S.; \$2.50 elsewhere.

Reviewed by E. J. Charlton[2]

IF you want a panorama of recent progress in the use of welding as an engineering tool, this book will deeply interest you. Any attempt at an adequate review of it is a most difficult assignment. The editors present the latest volume in what amounts to a progressive encyclopedia devoted to the welding industry. Any individual attempting a review of a piece of literature of encyclopedic breadth is surely faced with a difficult task.

The engineering profession as a whole is indebted to Professor Green and his associate editors for this excellent addition to the literature. "Design for Welding" also deserves careful study by those of us who are not familiar with the concepts of the James F. Lincoln Arc Welding Foundation. It represents the continuing effort of a well-founded element in the welding industry to add to the stature of that industry and particularly to its engineering literature. It seems reasonable to state that there is no counterpart in other engineering endeavors to the activities of this Foundation.

With respect to the current volume, or those that have preceded it, abstract engineering criticism might be in order. Any such reflection on how the book fails to fulfill the requirements of an engineering treatise, however, would seem to be naive if not quibbling in nature. The fact will always remain that the Lincoln

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[2] Manager, Development Engineering Division, Lukens Steel Company, Coatesville, Pa. Mem. ASME.

Foundation and its editors have applied real effort and large sums of money in this excellent contribution to engineering progress. They have chosen to use a sharp tool in doing this. Everything set forth in the literature resulting from this continuing endeavor is the result of competitive thinking and presentation.

It seems pointless for engineers devoted to long established, highly evolved fields of endeavor to question this basic procedure. It is a dynamic part of the phenomenal growth of a still relatively new engineering tool, which welding in its many aspects certainly is. The engineering profession in general should at this point confine itself to the expectation that the Lincoln Foundation will recognize when a pioneering endeavor and its resulting somewhat erratic literature should cease or, at least, change its course. The publishers of this book and its editors will undoubtedly realize in due time that a fundamental "taking of stock" will be most valuable in addition to a continuing "running commentary." The basis and form of such an addition to the literature is for them to decide. It should suffice for us to assume that one day a basic text, or series of such, on the subject of welding as an engineering tool will emerge. So far, no more qualified agency than the Lincoln Foundation, considering its method, has appeared.

Practically every phase of engineering endeavor has its more or less standard or basic text. Properly, such has not yet appeared for the welding industry. It will. Since the unrelated technical data already published on the subject reach astronomical proportions, anyone attempting to impart the engineering fundamentals of welding has an increasingly difficult job. If this need is real, it might be of value for all interested engineers to profess openly their ideas concerning it to both the Lincoln Foundation and the American Welding Society. Certainly the ASME has a definite interest in such contributions to the literature because welding as a modern engineering tool has no broader application than that in the mechanical-engineering field.

The book is not a fundamental treatise on welding design as its title might imply. It is a well-edited selection of prize-winning papers from the most recent J. F. Lincoln Arc Welding Foundation contest. It is the practice of this Foundation to publish a selection of such papers after each of its contests. Previous volumes have been published, and as previously stated, the whole represents a running history of progress in the expanding use of welding during the past several years. This is the intention of the Foundation and it is admirably fulfilled in the contents of the current book.

It is to be noted that the eighty-two papers composing the book were selected from over eleven hundred. It is a reasonable assumption, therefore, that the contents represent the work of top-level engineers in the welding industry. It is also worthy of note that the data offered are not theory or abstract ideas. Every design application described has been executed and put into service.

However, as a text for the student of welding design, the book by its nature leaves something to be desired as has been previously implied. Engineering fundamentals that must exist for the eighty-two instances described have not been lifted out and summarized. No over-all conclusions have been drawn and presented. In other words, it would seem difficult for the raw student of welding design to utilize this book as a text. It is necessary for him to plow through eighty-two different authors all describing separate design approaches.

One also wonders whether there is any real value in the cost data presented considering the qualifying statement in the second paragraph of the preface. This says:

"It is to be recognized that the size of plant, the location, and the type of accounting system used have a large effect upon specific costs quoted. The greatest use for these cost figures is found in the comparison made between methods of manufacture and not in the possibility of duplication by other organizations."

Rather than comparison being the greatest use, it would seem to be the only real use.

On the other hand, the book can be of real value as a reference book and history. You can at least go to this volume and find out how eighty-two different designs in welding were accomplished by more than eighty-two people in widely diversified industries. The applications exemplified embrace industrial equipment in a sweeping manner.

It is essential that the reader of this book carefully note the preface and the conditions of the contest which are set forth in the first pages.

Engineering Metals and Their Alloys

Engineering Metals and Their Alloys. By Carl H. Samans. The Macmillan Company, College Department, New York, N. Y., 1949. Cloth, $6 \times 9^{1}/_{4}$ in., tables, figs., illus., xiii and 913 pp., $7.50.

Reviewed by W. Trinks[3]

THIS book is a complete college course in metallurgy, all in one volume. The scope is very comprehensive; it includes: General characteristics of the metallic engineering materials, 63 pages; the pure metal, 42 pages; metallurgical methods, 18 pages; production of the metals—magnesium, aluminum, and zinc—from their ores, 31 pages; the production of pig iron and cast iron, 25 pages; iron and steelmaking, 47 pages; production of the metals—copper, nickel, lead, and tin—from their ores, 35 pages; the theory of alloys, 73 pages; the principles of heat-treatment, 55 pages; shaping and forming the metallic materials, 94 pages; corrosion, its effects and control, 14 pages; protecting metals against corrosion, 27 pages; alloys used largely because of ease of fabrication, 47 pages; pipe, tubing, and castings resistant to water corrosion, 21 pages; alloys resistant to chemical corrosion and the action of heat, 71 pages; alloys for applications requiring high strength and toughness, 67 pages; alloys resistant to general wear and abrasion, 29 pages; tool materials, 41 pages; bearing alloys, 31 pages; alloys used because of their special physical properties, 53 pages.

This array of titles does not do justice to the book because some of the chapters contain up to 30 subdivisions.

It required a patient and industrious author to write the book under review. This fact is evident from the very large number of sources and references cited. Each fact and figure is backed by at least one reference.

It is indeed a pleasure to read Dr. Samans' book, although it took the reviewer (who is fairly familiar with metallurgy) more than 80 hours to complete the reading. The style is clear and to the point, the photomicrographs are clear, and the illustrations are well marked. Perhaps there are too many photomicrographs. If all of them were cut from the book and were, without identification marks, tacked or pasted on a board, out of regular order, the reviewer could not identify more than about three per cent. The author can probably do better.

Since the book was written mainly for engineers, it is very commendable that the author has not discarded the Fahrenheit scale. So many metallurgists consider the centigrade scale to be more scientific.

The book is remarkably free from misprints and misstatements. The only bad slip occurs on page 596, line 16.

The reviewer most heartily subscribes

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[3] Partner, Associated Engineers, Pittsburgh, Pa. Fellow ASME.

to a slight modification of a statement in the author's preface: "Even with a limited treatment of (metallurgical) materials, the book must be large. While broad metallurgists will be grateful (for the limited treatment) others may feel that too much detail has been omitted in their particular specialty." Since the book is intended to serve as a text, it could not very well be made larger. Nevertheless the reviewer believes that the methods of converting tin-plate scrap and tin cans into tin-free scrap and iron-free tin might well have been included; for, if we reclaim all of our scrap tin, very little importation of tin will be needed. This, of course, is wishful thinking for the next edition.

The subjects are well arranged, in logical order. For that reason, Dr. Samans' book compares well with its formidable competitor, the "Metals Handbook."

So buy yourself a copy of Samans' "Engineering Metals and Their Alloys" and be prepared for reading which is both enjoyable and profitable.

Cybernetics

Cybernetics: Or Control and Communication in the Animal and the Machine. By Norbert Wiener. John Wiley and Sons, Inc., New York, N. Y., 1948. Cloth, 6 × 9 in., 194 pp., $3.

Reviewed by R. L. Snyder[4]

In "Cybernetics" (from the Greek equivalent of steersman) Professor Wiener has initiated the formal coalescence of those concepts which are common to people dealing with nervous systems and to those concerned with communication and computing equipment. An extensive introduction presents the author's associates and describes the environment wherein this work was done. The first chapter discusses "Newtonian and Bergsonian Time" in which, if time could be reversed, the former deals with phenomena which can be imagined to reverse and the latter with those which cannot. The next two chapters, "Groups and Statistical Mechanics," and "Time Series and Communication," are devoted to mathematical treatments of these subjects. In chapter four, "Feedback and Oscillation," it is shown that certain nervous disorders are similar to maladjustments in servo systems and are subject to the criteria laid down some years ago by Harry Nyquist. Under "Computing Machines and the Nervous System," are considered analog and digital computers along with the binary system used in the digital machines which seems to be very similar to that of the nerves. "Gestalt and Universals" deals with the puzzling ability of the mind to deduce whole meanings from fragmentary information. "Cybernetics and Psychopathology," compares the treatment of mental disorders with the repair of erring computing machines. The final chapter, "Information, Language, and Society," includes a surprising discourse on the morality of human society. In this book, the writing is highly technical; much of it is surely beyond the grasp of those with little practice in mathematics. Nevertheless, by deducing and bringing together many principles common to a group of more or less independent fields, communication, control, computing, physiological phenomena, the author has made a major contribution to the simplification, unification, and understanding of a large technical area.

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Books Received in Library

Design and Cost Estimating of All Types of Merchant and Passenger Ships. By A. Kari. Fifth edition, revised. Technical Press, Ltd., London, England, 1948. Cloth, 6 × 10 in., 384 pp., diagrams, charts, tables, $20. (Obtainable from E. W. Sweetman, 1 Broadway, New York 4, N. Y.) This book aims to be more than a treatise on naval architecture. It is intended to be a compilation of information reflecting the combined views of owner, builder, and operator. The ship is conceived as a functional entity, not merely a unit of physical construction, and the material on design, weight, and cost estimating, powering, and interior arrangement is presented from that viewpoint. Many tables and diagrams for practical use are given. This fifth edition is revised and brought up to date. Data on labor cost in man-hours are now included.

Diamond Tool Patents III, Truing of Grinding Wheels. By W. Jacobsohn. Industrial Diamond Information Bureau, Industrial Distributors (Sales) Ltd., London, E.C. 1, England, December, 1948. Paper, $7^{1}/_{4} \times 9^{1}/_{2}$ in., 87 pp., diagrams, tables, 12s, 6d. Some 500 abstracts are given of British, American, and German patents referring to the design, arrangement, or use of a particular truing device. The years from 1916 to 1946 are covered. The patents are classified and the abstracts are printed in numerical order by countries. Succeeding publications will similarly abstract patents in other fields of the diamond industry.

Engineering Metals and Their Alloys. By C. H. Samans. Macmillan Company, New York, N.Y., 1949. Cloth, $6 \times 9^{1}/_{2}$ in., 913 pp., illus., diagrams, charts, tables, $7.50. This text gives a comprehensive background of metallurgy which should fill the needs of any user of metallic materials. It can be used as a college text for courses dealing with production, physical, or engineering metallurgy. Metals are dealt with in groups according to applications. Their production from ores, heat-treatment, shaping, and forming are considered, as well as means of corrosion protection. Tables, diagrams, photomicrographs, and references are included.

Engineering Optics. By K. J. Habell and A. Cox. Sir Isaac Pitman & Sons, Ltd., London, England, 1948. Cloth, $5^{1}/_{4} \times 8^{1}/_{2}$ in., 411 pp., illus., diagrams, charts, tables, 35s. This book presents a critical survey of the most important optical methods and instruments that are applicable to engineering practice. The properties of ideal optical systems and actual systems are discussed. Light and illumination, microscopes, telescopes, optical projection, and profile microscopes are considered in detail. References are given at the end of each chapter but one.

Essential Metallurgy for Engineers. By A. C. Vivian. Third edition. Sir Isaac Pitman & Sons, Ltd., London, England, 1948. Cloth, $5^{1}/_{2} \times 8^{3}/_{4}$ in., 180 pp., illus., diagrams, charts, tables, 12s, 6d. Written for engineering students, this book is devoted to the causes and control of the properties of metals and alloys. Amorphous and crystalline structure, solid solutions, and eutectics are considered prior to mechanical properties and metallurgical techniques. Various alloys are dealt with in detail. A glossary of terms is included.

Handbook of Plastics. By H. R. Simonds, A. J. Weith, and M. H. Bigelow. Second edition. D. Van Nostrand Co., Inc., Toronto, Canada, New York, N.Y., London, England, 1949. Cloth, $6^{1}/_{2} \times 9^{1}/_{2}$ in., 1511 pp., illus., diagrams, charts, tables, $25. Beginning with a survey of the industry which lists producers and fabricators, this book covers the plastics field exhaustively from raw materials to finished products. It gives details of the manufacturing methods, machinery, and processes for the plastics themselves; also for the many articles into which they are fabricated. It includes plastics of all compositions and all manufacturers, with the specific properties which determine their applications and their choice for any particular purpose, use, or method of processing. The thorough revision includes the enlarging of the chapters on chemistry and on analysis, the full coverage of postforming and low-pressure molding, and the addition of sections on laminating, stress and strain, patents and accounting. There is a 57-page list of trade names and trade marks.

Ingenieure, Baumeister einer Besseren Welt. By F. Münzinger. Third edition. Springer-Verlag, Berlin, Göttingen, 1947. Stiff cardboard, $5^{3}/_{4} \times 8^{1}/_{2}$ in., 263 pp., charts, tables. The important topics dealt with are (1) the relation between technology and the sociological aspects of civilization, and (2) the contributions and obligations of the engineer to society. The author also discusses, among other things, the influence of engineering training on men, and follows the history of certain inventions with particular attention to their consequences. The book closes with a speculation on the hypothetical reaction of a resurrected member of a past generation to the current disturbed state of affairs.

Moulds for Plastics. By W. M. Halliday. English Universities Press, Ltd., for Temple Press, Ltd., London, England, 1948. Cloth, $5^{1}/_{2} \times 8^{3}/_{4}$ in., 259 pp., diagrams, charts, tables, 30s. Meeting the needs of both mold designer and toolmaker, this book deals with the varied and numerous problems associated with mold designing, construction, operation, and efficient maintenance. A number of illustrations of preferred design forms of the basic mold elements are included.

Non-Ferrous Castings. By R. F. Hudson, foreword by G. T. Hyslop. Chapman & Hall, Ltd., London, England, 1948. Cloth, $5^1/_4 \times 8^3/_4$ in., 282 pp., plus Appendix i–xxiii, illus., diagrams, charts, tables, 22s. Written for the practical man, this book gives a simple outline of the modern methods used in a nonferrous foundry which manufactures copper- and nickel-base alloys. It starts with a brief description of the main incoming materials such as metals and fuels. Then follow chapters dealing with refractories, molding, and core sands. Molding, melting, and gating practice are dealt with in detail. Permanent-mold casting, centrifugal casting, and casting salvage and repair are briefly considered. Photomicrographs showing constituents and photographs showing common defects are appended.

Personnel Management. By W. D. Scott, R. C. Clothier, and W. R. Spriegel. Fourth edition, McGraw-Hill Book Co., Inc., New York, N. Y., Toronto, Canada, London, England, 1949. Cloth, $6 \times 9^1/_4$ in., 648 pp., illus., diagrams, charts, tables, $4.50. Of value to students and businessmen, this revised edition presents a comprehensive outline of up-to-date principles, practices, and instruments in the important relationships between management and workers. The revision includes new chapters on the development of the union movement and on communicating with employees. Throughout, the authors assume a mutual interest on the part of employer, employee, community, and government. One of the features is the description of the role played by psychology in the initial selection, transfer, and promotion of employees and in the realm of training, morale measurement, and development.

Pittsburgh International Conference on Surface Reactions. Corrosion Publishing Company, Pittsburgh, Pa., 1948. Paper, $8^1/_2 \times 11$ in., 236 pp., illus., diagrams, charts, tables, $10; $6.50 to those attending Conference. The meetings of this conference, which was intended to stimulate the exchange of scientific information, were organized around the following general subjects: theory of liquid-phase reactions; theory of oxidation and surface reactions; preparation of surfaces; new methods and results; methods and results; fundamental mechanisms; and corrosion and its measurement. Eleven of the twenty-eight papers were presented by specialists from countries other than the United States. The conference was sponsored by seven national and regional organizations.

Plasticity in Engineering. By F. K. Th. van Iterson. Hafner Publishing Company, New York, N. Y., 1947. Cloth, $6 \times 8^3/_4$ in., 174 pp., illus., diagrams, charts, tables, $2.50. Of interest to both mechanical and metallurgical engineers, this book discusses both experimental and mathematical results. Such topics are dealt with as the behavior of mild steel when rupturing at the strain limit and the formulation of the laws of three-dimensional plastic flow. The fourth state of aggregation, between the solid and liquid, is introduced.

Rubber to Metal Bonding. By S. Buchan. Crosby Lockwood & Son, Ltd., London, England, 1948. Cloth, $5^1/_2 \times 8^3/_4$ in., 239 pp., illus., diagrams, charts, tables, 21s. This work on the use of rubber as a constructional unit deals particularly with the process which utilizes brass plating as a bonding agent, although other bonding agents are discussed. Both natural and synthetic rubbers are considered, molding methods are described, and the mechanism of the rubber-to-brass bond is gone into in detail. The bibliography consists of data sources referred to in the text.

Rocket Propulsion Elements. By G. P. Sutton. John Wiley & Sons, Inc., New York, N. Y.; Chapman & Hall, Ltd., London, England; 1949. Cloth, $5^1/_2 \times 8^1/_2$ in., 294 pp., illus., diagrams, charts, tables, $4.50. Designed as a reference manual as well as a college text, this book presents both the basic elements and the technical problems of rocket-propulsion systems. Emphasis is placed more on liquid-propellant rockets rather than on solid-propellant units, but the material on thermodynamic, thermochemical, and ballistic principles applies to both types. Examples, problems, illustrations, and references are included.

Scientific Foundations of Vacuum Technique. By S. Dushman. John Wiley & Sons, Inc., New York, N. Y., Chapman & Hall, London, England, 1949. Cloth, $5^3/_4 \times 9^1/_4$ in., 882 pp., illus., diagrams, charts, tables, $15. This book is a comprehensive study of all phases of achieving, maintaining, and measuring very low gas pressures. It presents a survey of fundamental ideas in physics, chemistry, and metallurgy, which will be found useful in dealing with problems in this field. References to the literature appear as footnotes. Both scientific research and practical engineering applications are considered.

Steam Boiler Yearbook and Manual (IV). Edited by S. D. Scorer. Paul Elek Publishers, Ltd., London, E.C. 1, England, 1948. Cloth, $5^1/_2 \times 8^1/_2$ in., 589 pp., illus., diagrams, charts, tables, 30s. This book contains an accumulation of useful data on the steam-generating field. Part 1 presents illustrated descriptions of almost every kind of steam boiler and associated plant and is a guide to modern British steam-boiler practice. Part 2 deals mainly with operating problems and incorporates material on modern boiler practice and development taken from English and foreign sources.

Story of Magnesium. By W. H. Gross. American Society for Metals, Cleveland, Ohio, 1949. Cloth, $5 \times 7^3/_4$ in., 258 pp., illus., diagrams, charts, tables, $1.50. This volume, written for the layman, deals mainly with the technology of magnesium. Methods of making this metal from rocks, brines, and seawater as well as the properties of the metal and its alloys are discussed. The processes of casting, forging, and finishing are considered, and current uses are described.

Symposium on Internal Stresses in Metals and Alloys. (Monographs and Report Series No. 5.) Institute of Metals, London, S.W. 1, England, 1948. Cloth, $5^1/_2 \times 8^3/_4$ in., 485 pp., illus., diagrams, charts, tables, 42s; $8.65 in U. S. A. Of interest to mechanical and metallurgical engineers, this symposium contains thirty-six papers grouped under three main headings: the measurement of internal stresses; the origin, control, and removal of internal stresses; effects associated with internal stresses, both on the microscopic and the macroscopic scale. A wide variety of metals and conditioning is covered in the separate papers. Over one hundred pages of technical discussion of the papers presented have been appended.

Library Services

ENGINEERING Societies Library books may be borrowed by mail by ASME Members for a small handling charge. The Library also prepares bibliographies, maintains search and photostat services, and can provide microfilm copies of any item in its collection. Address inquiries to Ralph H. Phelps, Director, Engineering Societies Library, 29 West 39th St., New York 18, N. Y.

Theory and Application of $\int_0^z e^{-x^2}\,dx$ and $\int_0^z e^{-p^2y^2}\,dy \int_0^y e^{-x^2}\,dx$. By J. B. Rosser; reproduced by arrangement with the Office of Technical Tervices, Department of Commerce, by Mapleton House, publishers, 5415 Seventeenth Ave., Brooklyn 4, N. Y., 1948. Cloth, $5^1/_2 \times 8^3/_4$ in., 192 pp., charts, tables, $8. In this book the known methods for evaluating the single integral are collected and extended to more general values of Z. Suitable means for estimating the accuracy of computations are provided. Additional methods for computing the single integral and methods for the double integral are presented for the first time. Applications of these integrals are in the theory of probability and statistics, the theory of optics, the theory of heat transfer, and the theory of electrochemical diffusion.

Vectorial Mechanics. By E. A. Milne. Interscience Publishers, New York, N. Y., 1948. Cloth, $6 \times 9^3/_4$ in., 382 pp., diagrams, $7.50. This book demonstrates the use of vectorial methods in the establishment of general theorems and in the solution of problems in the field of mechanics. It begins with a discussion of vector algebra containing all the results needed for reading the whole volume. This is followed by a systematic account of line vectors. Part 3 deals with dynamics and contains a section on kinematics. Rigid dynamics and impulsive motion are also considered.

Training Employees and Managers. By E. G. Planty, W. S. McCord, and C. A. Efferson. Ronald Press Co., New York, N. Y., 1948. Cloth, $6 \times 9^1/_4$ in., 278 pp., illus., diagrams, tables, $5. This book provides those engaged in industrial-training work and those who wish to enter the field with a useful guide. The scope, objectives, and techniques of the training now being practiced by companies are set forth. Part 1 introduces the broad concepts which have been developed in recent years in the field of business and industrial training. Part 2 deals with the organization and administration of training. Part 3 is devoted to training programs and methods. Selected references in the major fields of the text are provided.

Proposed Revisions and Addenda to Boiler Construction Code

IT IS the policy of the Boiler Code Committee to receive and consider as promptly as possible any desired revisions of the rules and its codes. Any suggestions for revisions or modifications that are approved by the Committee will be recommended for addenda to the Code, to be included later in the proper place.

The following proposed revisions have been approved for publication as proposed addenda to the Code. They are published herewith with corresponding paragraph number to identify their location in the various sections of the Code and are submitted for criticism and approval from anyone interested therein.

It is to be noted that a proposed revision of the Code should not be considered final until formally adopted by the Council of the Society and issued as pink-colored addenda sheets. Added words are printed in SMALL CAPS; words to be deleted are enclosed in brackets [ ]. Communications should be addressed to the Secretary of the Boiler Code Committee, 29 West 39th St., New York 18, N. Y., in order that they may be presented to the Committee for consideration.

PAR. P-3. Revise as follows:

Open-hearth or electric-furnace steel pipe or steel tubing may be used for [a] boiler [drum or other] pressure parts exposed to the fire or products of combustion.

WHEN USED FOR INTERNAL PRESSURE THE USE OF THE SPECIFICATIONS IS LIMITED AS FOLLOWS:

(1) SPECIFICATIONS THAT CAN BE USED IN SIZES 24 IN. AND SMALLER: SA-106, SA-206, AND SA-280.

"(2) SPECIFICATIONS LIMITED TO 18 IN. SIZE AND SMALLER:

SA-53	SA-209
SA-83	SA-210
SA-135	SA-226
SA-178	SA-250
SA-192	

PAR. P-186(d). Revise third paragraph as follows:

Fusion-welded construction may be used in lieu of riveted joints in the fireboxes of internally fired boilers provided the welds are between two rows of stay bolts, or in the case of flat surfaces the weld is not less than one half of a stay bolt pitch from the corner. In vertical tubular and firebox types of boilers the [flanged-in] bottom edges of the plates may be attached by fusion welding provided the load due to internal pressure is carried by staybolting and the inside width of the waterleg does not exceed 4 in. AN ACCEPTABLE CONSTRUCTION IS as shown in Fig. P-11 WITH BOTH PLATES FLANGED. AS AN ALTERNATE CONSTRUCTION, ONE PLATE ONLY NEED BE FLANGED, PROVIDED THE WELD JOINING THE FLANGED PLATE TO THE STRAIGHT PLATE IS A GROOVE WELD HAVING PENETRATION FOR ITS FULL DEPTH AND THE WELD IS OUTSIDE OF THE HEADER. The plates may be considered as fully supported if the distance from the weld to the nearest row of stay bolts is not more than one half the pitch allowed by the formula in Par. P-199.

PAR. P-293. Revise first sentence to read: "When shutoffs are used IN THE PIPE CONNECTIONS to a water column OR GAGE GLASS. . . ."

PAR. P-295. Revise first part to read: "No outlet connections. . .shall be placed on the pipes connecting a water column OR GAGE GLASS to a boiler."

PAR. P-322(a). Revise as follows:

(a) IF [when] the gage glasses and gage cocks required by Pars. P-291 and P-294 are not connected [substantially] directly to the shell or drum of the boiler [a water column shall be used into which the gage glass and gage cocks shall be connected] except as modified by the text preceding Par. P-1, THEY SHALL BE CONNECTED BY ONE OF THE FOLLOWING METHODS:

(1) THE WATER GAGE GLASS OR GLASSES AND GAGE COCKS SHALL BE CONNECTED TO THE INTERVENING WATER COLUMN; OR

(2) WHEN ONLY WATER GAGE GLASSES ARE USED, THEY MAY BE MOUNTED AWAY FROM THE SHELL OR DRUM AND THE WATER COLUMN OMITTED, PROVIDED:

(a) THE TOP AND BOTTOM GAGE GLASS FITTINGS ARE ALIGNED, SUPPORTED, AND SECURED TO MAINTAIN THE ALIGNMENT OF THE GAGE GLASS;

(b) THE MINIMUM SIZE OF THE STEAM AND WATER CONNECTIONS SHALL BE 1 IN. PIPE SIZE AND EACH WATER GLASS SHALL BE PROVIDED WITH A VALVED DRAIN;

(c) THE STEAM AND WATER CONNECTION SHALL COMPLY WITH THE REQUIREMENTS OF (b), (c), AND (d).

In (b) change the first part to read: "The lower edge of the steam connection to a water column OR GAGE GLASS. . . . . . ."

In (c) change the first part to read: "The upper edge of the water connection to a water column OR GAGE GLASS. . . ."

Low-Pressure Heating Boiler Code, Preamble, revise as follows: The last sentence of the first paragraph to read:

They were not formulated to cover apparatus such as ordinary range water backs, range boilers, gas water heaters, OIL WATER HEATERS, and ELECTRIC WATER HEATERS for the production of domestic hot water supply.

Revise the second paragraph to read:

For the purposes of these rules. . . . .a range boiler is a ferrous or nonferrous tank for the storage of water at pressures not in excess of the maximum working pressure stamped thereon, at temperatures not in excess of 212 F, [the hot water may be supplied from an external source or the range boiler may have a self-contained gas or oil burner or electric heating unit] AND HAVING NO SELF-CONTAINED MEANS OF HEATING. A GAS, OIL, OR ELECTRIC DOMESTIC WATER HEATER IS ANY BOILER, RANGE BOILER, OR TANK EQUIPPED WITH INTEGRAL GAS OR OIL BURNERS OR ELECTRIC HEATERS, HAVING AN HOURLY BTU INPUT OF LESS THAN 100,000 BTU AND A WATER-CONTAINING CAPACITY OF 120 GAL OR LESS.

PAR. U-1(a). Add the following:

The pressure vessel under the requirements of this Code shall be considered to end at the first connection whether the nozzle be flanged or furnished with the end beveled or grooved for welding.

PAR. U-19(c). Revise as follows:

(c) The Code provides the limiting stresses for use in the design of pressure vessels and it is necessary to take account of the effects of static head AND ALL INFLUENCES OTHER THAN THE MAXIMUM ALLOWABLE WORKING PRESSURE in order that such stress limits be not exceeded.

PAR. U-36(m). Revise as follows:

Conical Heads Under Internal Pressure [where the angle α does not exceed 60 deg] the following formulas shall apply:

$$t = \frac{PD}{2\cos\alpha\,(SE - 0.6P)}$$

or

$$P = \frac{2\,SEt\cos\alpha}{D + 1.2t\cos\alpha}$$

where t = minimum required thickness (exclusive of corrosion allowance) of head plate after forming, inches,

P = maximum allowable working pressure, pounds per square inch,

D = inside diameter of the cone at the point under consideration, measured perpendicular to the longitudinal axis, inches,

α = one half of the included (apex) angle of the cone at the center line of the head, degrees,

S = maximum allowable working stress as given in Tables U-2 or U-3, pounds per square inch,

E = lowest efficiency of any joint in the head (exclusive of the joint to the shell): for riveted joints = calculated riveted efficiency; for fusion-welded joints = efficiency specified in Pars. U-68 and U-69; for Par. U-70 use the values of SE given in the paragraph.

[Where the angle α exceeds 60 deg conical heads shall be at least as thick as flat unstayed heads.]

When α exceeds 30 deg, conical heads shall be attached to the shell by a knuckle complying with the applicable provisions of Par. U-38, and the knuckle section shall meet the thickness requirements for the knuckles of spherically dished heads, using the formula in (a) in which

$$L = \frac{D}{2\cos\alpha}$$

and D = inside diameter of the cone at the point tangent to the knuckle measured perpendicular to the longitudinal axis, inches.

In no case shall the knuckle thickness be less than the thickness of the cone.

PAR. U-36. Add (n) as follows:

A head for a cylindrical shell may be built up of several shapes, each shape designed to have its wall thickness at least as thick as required by the appropriate formula above, provided that at each juncture the adjoining shapes are formed to coincide (have common tangents transversely to the joint). For abutting plate edges of unequal thicknesses, the taper required by Par. U-72(e) shall extend entirely within the boundary of the shape having the thinner wall.

THE ENGINEERING PROFESSION

News and Notes

As Compiled and Edited by A. F. Bochenek

Mechanical-Engineering Education Conference

How to Improve Engineering Education Discussed

THE third Mechanical Engineering Education Conference was held at the Engineers' Club, New York, N. Y., on March 21, 1949, on the invitation of The American Society of Mechanical Engineers. Societies in the field of mechanical engineering invited to the Conference were: The American Society for Engineering Education, American Society of Heating and Ventilating Engineers, American Society of Refrigerating Engineers, American Society of Tool Engineers, Institute of the Aeronautical Sciences, Instrument Society of America, and Society of Automotive Engineers. Present at the Conference, which was preceded by a dinner, were: David L. Arm (ASEE); Carl F. Kayan, Walter Fleischer, and M. C. Giannini (ASHVE); B. H. Jennings and M. C. Turpin (ASRE); H. L. Tigges (ASTE); Paul Harrington and R. R. Dexter (IAS); R. J. S. Pigott, T. L. Preble, J. A. C. Warner, and Hollester Moore (SAE); L. Austin Wright (Engineering Institute of Canada); and Ralph L. Goetzenberger, Guy Cowing, C. E. Davies, and George A. Stetson (ASME). Professor Kayan also represented the Instrument Society of America.

Mr. Goetzenberger, chairman, ASME Board on Education and Professional Status, presided and the program was arranged by a committee consisting of Dean Arm, Mr. Fleischer, and Mr. Preble. Leaders of the discussion were: C. E. Davies, H. P. Hammond, and L. J. Fletcher.

Purpose of the Conference

The Conference, which was the third to be held, provided a means of bringing together representatives of the mechanical-engineering societies for the discussion of subjects of common interest in the hope that, over a period of time, it would be possible to work toward closer co-operation. It also provided an opportunity for ASME to discharge the responsibility it undertakes to the other mechanical societies in representing the mechanical-engineering group of interests in the work of the Engineers' Council for Professional Development.

At the first Conference, held in March, 1947, discussion centered around mechanical-engineering education and the desirability of joint student branches at engineering colleges. At the second Conference, March 22, 1948, the accrediting procedure of ECPD was discussed by B. F. Dodge, member of the ECPD Committee on Engineering Schools. The second topic at the 1948 Conference was specialization in engineering education, which was introduced by Dean Arm. The third topic, Can the societies aid in imparting to the undergraduate student a better understanding of the professional obligations of the engineer? was also introduced by Dean Arm. A summary of the 1948 Conference appeared in Mechanical Engineering, May, 1948.

Program of the Third Conference

The Program Committee provided two topics for discussion at the 1949 Conference: (1) A report on the action and plans of ECPD; and (2) How can the efficiency of engineering education be improved?

In presenting the first topic Mr. Davies prefaced his remarks by stating that the reason for holding the Conferences lay in the belief of ASME that societies whose activities lay in the various fields of mechanical engineering should have an opportunity to discuss matters of common interest such as the Conference provided. One professional-engineering activity about which there was this common concern, he said, was ECPD, which was an agency of the entire profession. On ECPD the mechanical engineer was represented by ASME. One of the problems facing ECPD and ASME, he said, was how to bring a larger number of the mechanical societies into understanding of ECPD. The present meeting provides the vehicle for such understanding.

Mr. Davies then briefly reviewed the history of ECPD and its four committees and exhibited several examples of literature and reports issued by the Council. He emphasized principally the programs of the Committees on Student Selection and Guidance, Professional Training, and Professional Recognition. Local participation was particularly desired and necessary in the programs of the Committees on Student Selection and Guidance, and Professional Training. It was his hope, he concluded, that the local sections of the several societies represented at the Conference would assist ECPD in raising the level of the engineering profession.

Improving Engineering Education

Dean Arm then reviewed the discussion at previous conferences and said that the 1949 conference would consider how the efficiency of engineering education could be improved, and that Dean H. P. Hammond, of the Pennsylvania State College, and Leonard J. Fletcher, of the Caterpillar Tractor Company, would present the views of the educator and the industrialist, respectively.

In introducing his comments, Dean Hammond suggested that engineering-education administration for administration's sake was being overdone to the extent that officers of colleges were failing to keep in touch with educational progress and that they had, perhaps, assumed that changes in curriculums had provided a solution of the problems of engineering education. The crux of the matter was, in his opinion, to be found in the student, the teacher, and the subject matter and how it was taught.

Dean Hammond presented the suggestions which, in his opinion, would lead to increased efficiency in engineering education:

1 Poorly prepared and poorly qualified students should be excluded from engineering schools. Their admission leads to a high number of failures.

2 A simplified curriculum, with more attention given to fundamentals and greater concentration on a smaller amount of subject matter, would help. A decrease of 15 to 20 per cent of the ground to be covered was indicated.

3 A few broad principles should be thoroughly mastered.

4 "Teacher recitations" should be eliminated and the student made to do the work.

5 The student should be given an opportunity to do original work.

6 Recitation, laboratory, and design periods should be more closely co-ordinated.

7 About 20 per cent of the student's time should be devoted to the cultural stem of studies, provided those courses were, unit for unit, as valuable as the technical courses.

8 The place of the engineer in society should not be left entirely to the teachers of nontechnical courses; engineering teachers should also help to broaden the horizons of the engineering student.

9 The engineering curriculum should be lengthened for students who are to enter the higher levels of engineering practice; and the quality of postgraduate instruction in many institutions should be improved.

10 A higher quality of engineering teacher is needed.

The View of Industry

Mr. Fletcher said that in order to get better qualified young men into the engineering profession it was necessary to select the right men early in life, a task in which all engineers can help by working together at the local level.

As for engineering education, he favored a simplified curriculum and pointed out that fundamentals could be taught by means of application. There was, in his opinion, always room for improvement in the quality of group instruction. It was necessary to select instructors with care and to provide adequate materials. Attempts should be made to create interest and a habit of continuing education.

He recognized that there was a wide range of effectiveness of teaching in engineering colleges and that there was no formula for effective teaching. He offered the following suggestions for developing more effective teaching:

1 Change the emphasis from profound engineering knowledge to ability to teach fundamentals, with a reasonable amount of "up to dateness." Inspire the student.

2 Develop a favorable attitude toward improvement in teaching by means of conferences on teaching, criticism of a teacher's methods by other teachers, and by creating a pride in group accomplishment, thus helping one another to do a better job.

3 Create interest in members of the teaching staff.

4 Permit every teacher to achieve results in his own way, and set up goals of accomplishment.

5 Reward good teaching financially on the same basis that good research is rewarded.

Industry's contribution to effective engineering education, he said, would come first by making it clear what it wanted of the colleges, then by describing clearly the job of the engineer in industry, next by affording internships for engineering graduates, and finally, by providing working materials for the colleges.

Engineering graduates, he said, must learn how to handle men. It was typical of engineers, he asserted, to be interested in what could be put on a slide rule. Ability to handle people came, not from books, but from people, he said. This ability could be cultivated in the home, the school, the church, and the college. Although communication was exact in engineering, it was inexact in human relations. If engineering students were to get the most from humanistic studies, it was important for members of engineering faculties to be genuinely interested in humanistic subjects.

Following the presentation of these points of view of Dean Hammond and Mr. Fletcher, a general discussion ensued. G. A. S.

Income of Engineers

A RECENT survey of incomes of graduates of the University of Notre Dame throws some light on the earning capacity of engineers as compared with their colleagues in the fields of medicine, general business, law, and education. When the data provided by 2387 graduates were analyzed according to the number of years since graduation, the following observations were made:

1 In all fields the highest income is attained approximately 30 years after graduation.

2 The medical and legal fields yield the highest income over the longest period of time.

3 The income of those in the legal field, for the few reporting, increases rather sharply after 30 years, whereas in this same period the income of all other groups reflects a definite decrease, most outstandingly so in the case of engineers and scientists.

4 Those in general business receive the highest income for the first ten years, but after that time drop behind doctors and lawyers.

5 The teaching profession lags far behind the other fields and attracts a comparatively small proportion of graduates.

6 The majority of graduates reporting are in some form of business.

Income reported by engineers is worth noting. Average income of 203 of the engineering graduates five years out of school was $3918; the income of 76 engineers ten years out of school averaged $5807; 81 engineers 15 years after graduation reported average income of $7913; 76 engineers 20 years out, the average was $9998; for 19 engineers in the 30-year bracket the average was $21,027; six replies from engineers in the 40-year bracket reported an average income of $6079.

Engineering Enrollment Returning to Normal

THE enrollment in engineering colleges indicates a rapid readjustment back to prewar trends, according to an analysis made by S. C. Hollister, dean of engineering, Cornell University, published in the March issue of the *Journal of Engineering Education*. Enrollment figures collected by the American Society for Engineering Education show a freshman enrollment this year of 48,000 in engineering, representing a sharp decline from the enrollment of over 80,000 in 1946. The present freshman class is slightly greater than the trend of freshman registration in prewar years.

By 1952–1953 it is anticipated that the number of engineering graduates will reach the normal trend extended from prewar years Although the enrollments in upper classes are abnormally large due to a large veteran enrollment, Dean Hollister pointed out that these are, in considerable part, replacements for the large deficits during the war years. This deficit has been borne out by the acute shortage of engineers in the postwar era. The problem of absorption of engineers in industry, if there be one, will develop next year or the year after. Beyond 1951–1952, the number of engineering graduates each year will return to prewar trends, or perhaps fall slightly below these trends due to the decline in birth rate during the depression years of the 1930's.

In recent months statements have appeared in the public press that the rate of trained engineers is far beyond the demand, and that unless some means of replacing the number of engineering graduates is invoked, the prospects for many young engineers of finding suitable employment in the profession will be poor. Reliable information on this subject, however, does not bear out statements being made.

AWMA Seeks to Enlarge Membership

THE American Weldment Manufacturers Association, organized to promote the use of welding by American industry, recently opened its membership to all companies who do outside welding in addition to their own production. A new grade of associate member was also created to meet the needs of individuals and companies who are interested in the development and advancement of the weldment industry.

Among the projects planned by the association is the establishment of standards and practices of weldment manufacture. These standards are expected to cover all phases of quality control such as steel specifications; standard of welding and weld sizes; over-all tolerances; finishing by sand, steel grit, or shot blasting; stress relieving; and inspection. Another project getting under way is the development of a cost manual which will present a statement of all essential elements of cost together with recommended job costing procedure.

ECPD Personality Study

INTELLIGENCE is the most highly sought after personal quality in an engineering employee in the opinion of 44 of the nation's top-level engineering executives, who participated in a survey recently concluded by the Engineers Council for Professional Development to provide facts about human personality which would be valuable in its program of student and professional development.

The results of the three-year survey which was broadened to include opinions of college administrators, faculty, personnel officials, and engineering students, are published in a 25-page booklet, "The Most Desirable Personal Characteristics," in which the data submitted by 1033 respondents are plotted in 15 bar charts and curves, and interpreted by the ECPD Subcommittee on Student Development.

Dependability Rated Second

Asked to list six carefully selected positive characteristics of human personality in the order of the most desirable, 80 per cent of the executives gave first or second place to intelligence, thus rating it first among the desirable characteristics. Physical acceptability, defined as masculinity, good carriage, cleanliness, etc., was rated as least important, with 93 per cent of the respondents giving this characteristic fifth or sixth place. Dependability was rated second among the most desirable characteristics; organizational acceptability as third; energy as fourth; and emotional acceptability as fifth.

Surprisingly enough, the returns for engineering-school administrators, faculty, personnel officials, and even engineering students fell into the same order of importance as that charted by the executive group. In the case of students, a wider scattering of choice was indicated, particularly in the end positions where the more experienced respondents made decisive choices.

Interpretation of Characteristics

Another interesting result of the survey is the light it throws on the interpretation by the respondents of the meaning of the personal characteristics they were asked to rate. Six descriptive subheads were listed under each characteristic to clarify its meaning for those answering the questionnaire. For example, under the main characteristic, "intelligent," the following six subheads were listed: Clear thinking; reasonable; careful; imaginative; shrewd; and adaptable. Respondents were asked to list the subheads in order of importance. The returns were revealing.

In general there was good agreement on what the main characteristics meant. For all respondents the intelligent man was, first, one who was clear-thinking and, last, one who was shrewd. The dependable person was one who was truthful and not necessarily one who could get things done. Co-operativeness and consideration were rated the most important qualities of the organizationally acceptable man. But when it came to the term, dynamic, divergence of choices indicated that no one was sure just what the term really meant.

Aspect of Group Opinion

The survey bears out the hypothesis advanced by the ECPD Subcommittee on Student Development that while human personality could not be easily defined, most people had a good idea of what were the most desirable of the personal characteristics, and that, in fact, these ideas or intuitions about human personality had assumed the aspect of group opinion.

Early in 1946, Donald B. Prentice, Fellow ASME, at that time chairman of the ECPD Committee on Engineering Schools, expressed the hope of defining these desirable characteristics which industry seeks and the world needs, as an aid to students and young graduate engineers on the way to professional attainment. A Subcommittee on Student Development was subsequently formed under the chairmanship of A. R. Cullimore, Mem. ASME, then president of the Newark College of Engineering, to undertake a personality survey.

A questionnaire was prepared on the basis of six carefully selected personality characteristics, and a pilot group of engineering executives of considerable responsibility and diverse managerial functions residing in widespread geographical areas was enlisted to co-operate in the survey. All members of the pilot group were executives with experience in hiring and direction of young engineers and were known personally to at least one member of the committee.

The questionnaire consisted of three parts. The first listed the main characteristics each with six descriptive subheads which respondents were asked to rate in order of importance. The second part consisted of a Form 1 in which the main characteristics were to be listed in the order of the most desirable for men in the general engineering field. Part three was an optional Form 2 divided into the four functional engineering groups as follows: Research and invention; design and construction; production and management; and sales and distribution. Form 2 was to be used by those respondents who felt that the order of characteristics as listed for general engineering work was not valid for the various functional subdivisions of engineering.

Twenty-eight of the pilot group filled out Form 2, thereby providing significant data pointing up similarities and contrasts among the characteristics most valued by the functional groups.

Differences of Functional Groups

The desirable characteristics of the research and design groups fell in the same general pattern with the end positions filled by intelligence and physical acceptability, with a good concentration of choice in rating four of the six characteristics. A change, however, was noted in the production and management group. Here intelligence still had first place but held its lead by only a narrow margin with most of the other characteristics having higher ratings.

A radical departure from the usual arrangement of characteristics was noted in the sales and distribution group. Here "dynamic" rather than "intelligent" was the paramount quality with physical acceptability, which consistently rated sixth, running a close second.

The returns showed no concentration of choices, which was interpreted to mean there is no general type of sales personality.

While the committee feels that the survey was an important contribution to the field of personality study, it cautions against conceiving the project beyond what it was intended to be—"a rough measurement in a rugged terrain."

The ECPD is a conference organized in 1932 to enhance the professional status of the engineer through the co-operative efforts of the following national organizations concerned with the professional, technical, educational, and legislative phases of engineers' lives: American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, The Engineering Institute of Canada, American Society for Engineering Education, American Institute of Electrical Engineers, American Institute of Chemical Engineers, and the National Council of State Boards of Engineering Examiners.

Copies of the report may be obtained from ECPD, 29 West 39th Street, New York 18, N. Y. Price per copy is 25 cents.

Future of Coal Subject of ACI 27th Fuel Engineering Conference

THE twenty-seventh ACI Fuel Engineering Conference, sponsored jointly by the Detroit Section of The American Society of Mechanical Engineers and the Appalachian Coals, Inc. was attended by the largest group ever to be present at one of these meetings. The conference was held at the Rackham Educational Memorial Building, Detroit, Mich., March 9, 1949.

Speaking before a group of nearly 1000 fuel engineers, industrial executives, equipment manufacturers, consulting engineers, educational and research representatives, James D. Francis, president, Island Creek Company, Huntington, W. Va., talked about coal today and its future. Mr. Francis stressed the importance of coal to the nation, and that, if the coal industry is to be kept strong and free from Government regulation, "hundreds of millions and probably billions of dollars" must be invested in new mines and machinery over the next few years. Coal, with present wage and supply costs, is costing more to produce than at any time in the history of the industry, Mr. Francis said. He pointed out that because of these high costs many coal producers are unable to operate at a profit, and more investment in new machinery is needed if the industry is to stay on a sound basis.

High Cost of Mining Operations

Opening a large mine and getting it started, Mr. Francis said, is a slow process to bring up to maximum capacity. "The investment in these properties," according to Mr. Francis, "is two or three times as much as the cost of prewar properties that are now being exhausted." New operations today cost $6 to $7.50 per ton of annual production and in some instances run as high as $10. Probably less than 10 per cent of the coal being burned at the present time comes from new deep mines which were built since 1940. Mr. Francis said, "A reasonable estimate is that 20 per cent of the mines from which consumers are drawing their coals today will be exhausted within a period of five years, and that half of these mines will be exhausted, or abandoned, within a period of 10 years."

Quoting President Truman's annual economic report of this year, Mr. Francis emphasized that great potentialities for further mechanization of mining, handling, and cleaning operations exist in the coal-mining industry. He called attention to that section of the report which stated that "in relation to the output, coal mining requires a large capital investment which is only slowly recovered in earnings."

Speaking of competing fuels and their present use, Mr. Francis said, "If the Government would encourage the producers and refiners of petroleum to make these fuel oils into gasoline and lubricating oils, they would be doing more than anything else to conserve and extend the life of our petroleum products." He urged the proper use of natural gas and its conversion into gasoline to conserve the coal supply and keep it available for its most important use, stating that it requires a ton of coal to make two barrels of fuel oil, when a ton of coal under a boiler is worth more than four barrels of oil in heat units.

Standardized Boilers

Donald S. Walker, Mem. ASME, vice-president, Combustion Engineering-Superheater, Inc., New York, N. Y., speaking on "Standardized Design of Industrial Boiler Units," emphasized the many benefits to be derived from installations "with standardized designs of capacity, steam pressure and temperature, drums, tubes, and furnaces. Boilers that can be bought off-the-shelf from standardized tried-and-proved units." Mr. Walker pointed out, "this benefits not only the cost, due to elimination of large costs for engineering and design, but also shortens shipping time, even under present shortages, by as much as six months.

"By taking the 'whim' out of boiler design on the part of the purchaser, consulting engineer, and manufacturer," Mr. Walker said, "construction and delivery can be speeded up and costs cut. Whims cost a lot of money and serve no useful purpose."

Spreader Stoker

"The spreader stoker's growth has been due to many factors," said William S. Major, Mem. ASME, development engineer, Bituminous Coal Research, Inc., Pittsburgh, Pa., whose talk, "Spreader-Stoker-Fired Boiler Units," was enthusiastically received.

The spreader stoker's ability to use satisfactorily a wide range of sizes and types of coal, ease of operation and control, quick response to load demands, and low maintenance costs, even under high burning rates, are principally responsible for its wide acceptance in the field of steam generation, according to this research engineer.

Electric-Utility Industry

Walker L. Cisler, Mem. ASME, executive vice-president, The Detroit Edison Company, Detroit, Mich., as the principal speaker during the evening session said, "Private" utility systems will make an average annual investment of $1,500,000,000 in power-expansion programs in the next five years.

"The electric-utility industry and the coal industry have always been closely associated," said Mr. Cisler, "and together they have been major contributors to the high level of prosperity in this country."

The capacity of our existing electric utility systems amounts to 56,500,000 kilowatts, and with 13,000,000 kilowatts installed in industrial plants, transportation systems, and other generating plants the United States has a total of almost 70,000,000, a vast pool of electric generating power. "This is one of our most formidable resources for both peacetime pursuits and our national defense," he said.

Referring to the ever-increasing efficiency in the utilization of coal, Mr. Cisler said, "In 1914, a ton of coal produced 535 kwhr of electricity; in 1946, 1550 kwhr; and the modern steam plants of today and tomorrow will individually attain a production of 2500 kwhr per ton of coal."

Commenting on atomic power, Mr. Cisler said, "It is not expected that the so-called atomic pile will be furnishing heat for the generation of appreciable quantities of electricity for a long time. The work now under way by the Atomic Energy Commission should yield results in time, but those results are not in immediate prospect, due to many factors." For the foreseeable future, "Coal will be used in about two thirds of the new fuel-burning capacity."

In conclusion, Mr. Cisler pointed out that there is an immediate need for additional electric power all over the world, in order that living standards of other countries can be built up.

Cost Reduction

A 40 PER CENT reduction in the cost of products can be achieved by management if proper consideration is given to three basic phases of the materials-handling problems confronting industry, according to George B. Heddendorf, Babson Institute, Boston, Mass., who spoke before the Materials Handling Conference held recently at Purdue University, Lafayette, Ind.

Mr. Heddendorf listed the three phases as: (1) Plant location with reference to raw-material supplies and markets; (2) bulk movements of materials between departments within the plant and between plants; and (3) motion-economy principles governing efficient handling of pieces by operators at a machine or bench.

Contrary to the generally accepted belief that "costs of goods vary in direct proportion to direct labor and direct materials costs," Mr. Heddendorf stated that actually "costs vary in direct proportion to the indirect costs associated with manufacturing."

Instead of expending valuable time and money on marginal methods of improvements, Mr. Heddendorf expressed the opinion that "an effective program of worker training supplemented by conscientious and effective supervision would accomplish the same degree of savings at a minimum actual cost.

"I personally believe," he continued, "that the so-called X factor in employee attitudes is just as an effective weapon in the struggle for cost reduction as many of the mechanical developments and improvements on which we are too often prone to rely. As you probably recall, the X factor to which I refer is the one which was experienced at Western Electric some years ago. In that instance they took a small group of operators and proceeded to improve the so-called working conditions by better lighting, recess periods, time off, relief from other forms of restrictions, and after about a dozen experiments, in each of which production was stepped up, the investigators finally decided to find out how much they had accomplished. They were rather surprised to discover that when they went back to the original conditions of operation, which were looked upon as antiquated and unsatisfactory, that the operators again responded with a further increase in production, the highest figure achieved in the whole series of experiments."

WEC Bulletin Reports Activities

ORGANIZATION of the World Engineering Conference by the world engineering profession after three decades of planning, bears witness to the desire of engineers to restudy and amplify their responsibilities as demanded by an increasingly complicated society, according to Morris L. Cooke, Fellow ASME, whose article, "Random Thoughts on World Engineering," appears in the second bulletin of the World Engineering Conference.

Mr. Cooke is a member of the executive board of the U. S. National Commission of WEC organized by the Engineers Joint Council in August, 1947. The commission is currently receiving the support of The American Society of Mechanical Engineers and the American Society of Civil Engineers.

The bulletin is a 45-page document containing report of actions of the WEC Executive Board, a detailed program of the Second International Technical Congress held in Cairo, Egypt, in March, 1949, an account of the formation of a sister organization, International Union of Architects, reports of 14 international meetings on such subjects as large dams, illumination, agricultural industries, applied mechanics, and television; nine national engineering events held in France, Belgium, Hungary, and Czechoslovakia; and announcements of forthcoming international meetings of interest to engineers.

With the admission of Syria, Uruguay, Lebanon, and Turkey, national membership in the WEC now stands at 11 nations, including the United States. Engineering organizations in nine other countries have affiliated with the WEC and six others to maintain an informal relationship and keep informed of its activities.

Co-Operation With UNESCO

According to the bulletin, WEC is co-operating with the United Nations Organization and particularly with UNESCO (United Nations Educational, Scientific, and Cultural Organization) on many fronts. In recognition of WEC contribution in international affairs, WEC was granted "consultative status" and invited to participate in the UNESCO General Conference at Beyrouth, Lebanon, in November, 1948. In connection with the WEC Cairo Congress, UNESCO provided a subsidy to facilitate publication and distribution of congress papers. As an information center on world engineering WEC is aiding UNESCO in the preparation of an International Yearbook of Associations of Engineers and Technicians which will list pertinent information on engineering organizations in all countries. Another project in which WEC has been helpful is the UNESCO study of the need and appropriate activities of a series of international scientific laboratories to be established in various parts of the world. WEC has stressed the need for an engineering representative on the restricted committee appointed to consider proposals which have been submitted. Engineering representation has also been assured by invitation of the WEC to participate in the International Conference on Scientific Abstracts planned by UNESCO for June, 1949.

Architects and Engineers

Also reported in the bulletin is the creation of an International Union of Architects which parallels in many respects the WEC. The organizational meeting was held at Lausanne University, Switzerland, August, 1948, and was attended by architects of 30 countries. Concerned with the responsibility of the architect to society and realizing the support that two organizations working on the same general problem can give to one another, the two bodies have decided to work together. To celebrate this expression of co-operation, officials of the IUA met informally with the WEC executive board in Paris in October, 1948. Present on this occasion was the French Minister of Construction who commented, in a brief address, on the benefits which can accrue from collaboration of the architect and the engineer.

"And how much finer—and at the same time, how much more efficient," he said, "will be the factories, the port installations, the gigantic industrial, petroleum, or mining plants which will have been worked with the supreme collaboration of the architect. How much more rational and comfortable and how much more rapidly erected will be the dwellings in the planning of which the architect has had recourse to the collaboration of the engineer."

U. S. Air Force Establishes Broad Research Policy

UNITED STATES Air Forces have recently established a broad policy foundation to be followed by all Air Force organizations participating in research and development.

Air Force regulation 80–4, under consideration since early last summer, represents the combined opinions of Air Force research personnel and leading civilian scientific figures in the United States.

Commenting on the new regulation, Theodor von Kármán, Mem. ASME, chairman of the Scientific Advisory Board, said, "The adoption of this regulation represents a major forward step in the Air Force's research and development program."

Efforts will be made to broaden the individual scientist's understanding of other research programs sponsored by the U.S.A.F., with particular attention to results obtained in the individual scientist's specialty. Assignment of scientists will be made to obtain the best possible utilization of each individual capability.

The regulation promises to augment the scientific effort available to the Air Force by liberalizing methods for hiring of consultants and for the letting of contracts and subcontracts for scientific research.

The regulation further requires the Air Force to avoid breakdown of research into compartments in so far as security will permit, and promises maximum co-ordination between individuals and research organizations. Air Force research policies are co-ordinated with the Scientific Advisory Board.

New Lubrication Committee Organized

TO stimulate contributions to the field of mechanical theory and practice of lubrication, The American Society of Mechanical Engineers recently organized a Co-Ordinating Committee on Lubrication composed of representatives of nine professional divisions of the Society.

The new committee will serve as a central administrative body whose object will be to strengthen ASME technical activities in a field where Society efforts in the past have been diffused and without effective leadership.

Officers

Organization meeting of the Committee was held on Jan. 20, 1949, at which the following were elected as officers for 1949: Chairman, A. C. Stutson, Socony-Vacuum Oil Company, New York, N. Y.; vice-chairman, A. H. Church, mechanical-engineering department, New York University, New York, N. Y.; and secretary, J. S. Burwell, Massachusetts Institute of Technology, Cambridge, Mass.

The following Professional Divisions participated in the meeting: Power, Applied Mechanics, Machine Design, Aviation, Oil and Gas Power, Production Engineering, Process Industries, Gas Turbine Power, and Petroleum.

Referring to the work of other technical societies active in the field of lubrication, the petition for formation of an ASME lubrication co-ordinating committee stated:

"Other organizations such as API, ASTM, SAE, and ASLE have definite contributions to make in certain phases of lubrication, and are making them. ASME, because of the nature of its membership and wide range of technical activities, is ideally situated to deal with a sector of this field that is of tremendous practical importance—the mechanical theory and practice of lubrication, and the mechanical application and use of lubrication on machinery of all types. It is not making the contribution it should because its efforts are diffused and lack the stimulation and co-ordination of centralized direction by members whose primary interest is lubrication."

Objectives

Objectives of the Committee as stated in the petition are to "foster basic and applied research in lubrication, prepare recommended procedures and practices, technical papers, and programs, and disseminate educational material. To achieve these objectives, the Co-Ordinating Committee on Lubrication will: (1) Work with professional divisions and interested committees in program planning, stimulating the presentation of worth-while papers on lubrication, and co-ordinating such programs for maximum effectiveness; (2) develop special projects in the lubrication field, either for the Research Committee on Lubrication or for special committees; (3) maintain liaison with other societies and groups working in the field of lubrication, co-ordinating ASME activities with theirs; (4) stimulate preparation of recommended practices and procedures either within ASME or in co-operation with other groups, as indicated by the nature of the work; (5) provide a centralized medium for the exchange of information on the mechanical phases of lubrication; and (6) sponsor and disseminate practical educational material on lubrication principles and practices. It is understood that such activities will be carried out within the existing ASME framework for research, standards, and professional activities."

Engineering Literature

Oil and Gas Power

AT ITS national conference held in St. Louis, Mo., in May, 1948, the Oil and Gas Power Division of The American Society of Mechanical Engineers commemorated the golden jubilee of the Diesel engine in America by presenting a comprehensive review of the historical development of this prime mover in the United States, as well as an evaluation of current applications of Diesel engines in industry, ocean and inland-waterways transportation, and in the railroad field. Another feature of the conference was a special lecture course on lubrication.

Three important publications, recently published by The American Society of Mechanical Engineers, have been added to the literature of the Diesel engine as a result of this conference.

The first is a 75-page Proceedings containing seven papers on such subjects as: improved techniques in the study of engine firing orders using the vectorscope, centrifugal blowers for Diesel engines, calculations of vibrations in engines, and four other papers on the application of Diesel engines in industry, marine and rail transportation. Price is $2.

The second is a 77-page booklet, "The First Fifty Years of the Diesel Engine in America," containing the four historical papers presented during the conference. The first paper covers the growth of the Diesel industry in America, and lists the manufacturers and their contribution to the field. Other papers deal with the development of the high-speed Diesel, the present status of the large Diesel in America, and a review of the research development of the Diesel and the newer reciprocation heat engines. The two booklets, in effect, present one of the most authoritative surveys of the Diesel industry currently available. Price is $2.

Of special interest to workers in the field is the third publication stemming from the 1948 conference. This is the 42-page booklet, "Diesel Lubrication Oils and Basic Principles of Lubrication," which contains the three lectures with discussion presented at the pre-conference lecture course. The lectures cover manufacture, classification, and test significance of Diesel lubrication oils, basic principles of lubrication, and a review of engineering application of these principles. The original lectures, for which a registration fee of $12 to members and $15 to nonmembers was charged, were limited to an audience of 100 engineers. Price is $1.50.

Copies of the three publications may be obtained from ASME Publication-Sales Department, 29 West 39th Street, New York 18, N. Y.

Cut-Off Blades

PUBLICATION by The American Society of Mechanical Engineers of the American standard, "Straight Cut-Off Blades for Lathes and Screw Machines ASA B5.21–1949," brings to a successful conclusion a standardization effort which began in 1932. The new standard sponsored by the Metal Cutting Tool Institute, Society of Automotive Engineers, National Machine Tool Builders' Association, and The American Society of Mechanical Engineers, recommends the four optional shapes of this important metal-cutting tool. These are: A, without side clearance; B, with straight side clearance; C, with concaved side clearance; and D, a channeled side blade for heavy duty made in heights of 1 in. or greater. Blade widths range from $^1/_{16}$ to $^1/_4$ in.; heights from $^1/_2$ to $1^1/_8$ in.; and lengths from $4^1/_2$ to $6^1/_2$ in.

German Gas Turbines

A 46-PAGE report on German gas-turbine developments during 1939–1945 was recently published by the British Intelligence Objectives Subcommittee. German work in gas-turbine power generation, and marine, armored fighting vehicles, and aircraft applications are covered. Design of component parts, materials, test equipment, and administration of gas-turbine development are also discussed. The pamphlet, "BIOS Overall Report No. 12," may be obtained from the British Information Services, 30 Rockefeller Plaza, New York 20, N. Y. Price per copy is 35 cents.

Panel Heating

A BIBLIOGRAPHY on panel heating has recently been published by the American Society of Heating and Ventilating Engineers, 51 Madison Ave., New York 10, N. Y. It contains over 330 references many of which are accompanied by brief abstracts or critical reviews. The publication is available to nonmembers of the ASHVE for 50 cents.

Steel Plates

"STEEL Plates and Their Fabrication," a reference book for engineers edited by Lionel S. Marks, Fellow ASME, has been published recently by Lukens Steel Company, Coatesville, Pa. The 408-page book contains extensive data of value as reference in selecting steel plates best suited for particular projects. The book contains analyses of physical properties of carbon and low-alloy steels, with charts and tables showing their behavior under sustained and repeated loadings, and their resistance to abrasion, corrosion, and temperature.

Engineers who work with steel plates are invited by the company to request a copy of the book on their company letterhead. Address: Lukens Steel Company, 10 Highway Building, Coatesville, Pa.

New Screw-Thread Standard Available Soon

THE new American Standard is being published by The American Society of Mechanical Engineers. It is expected that copies will be available soon. The ASME in cooperation with the Society of Automotive Engineers sponsored the committee under American Standards Association procedure that prepared this standard and represented the viewpoint of American industry in the discussions of the unification plan held with British and Canadian experts.

This American Standard, "Unified and American Screw Threads for Bolts, Nuts, and Other Threaded Parts, B1.1-1949," presents in tables, diagrams, and formulas the dimensions of the Unified Threads, as well as those threads which for the time being remain standard in the United States alone.

So many requests for information on the Unified Threads have been received from industry that the American Standards Association has prepared a detailed analysis of the new American Standard, including a comparison with the 1935 edition which it supersedes. Copies of this analysis are available upon request from ASA, 70 East 45th Street, New York 17, N. Y.

Air Flow

TRANSLATION of a German thesis on airflow measurement, unusual because the author at the early date of 1911 did considerable work with velocity above the acoustic velocity, has been prepared by Lyman M. Van der Pyl, chairman, Bibliography Committee, Industrial Instruments and Regulators Division of The American Society of Mechanical Engineers. Copy of the translation, "Contribution of the Measurement of Air Flow," by H. Bachmann, has been deposited in the Engineering Societies Library, 29 West 39th Street, New York 18, N. Y., where it is available for consultation or a photostatic copy can be supplied. Cost of a photostatic copy, $25.20.

Notes on Coming Meetings

Numerical Analysis

THE National Bureau of Standards is planning two symposiums on the effective utilization of automatic digital computing machinery to be held in June, 1949, at the Institute for Numerical Analysis of the Bureau in Los Angeles, Calif.

The first symposium will deal with the applications of conformal maps in such fields as aerodynamics and electronics and the current needs of research workers. Methods of constructing conformal maps and the problem of programming them on existing and proposed automatic digital computing systems, will be discussed with particular reference to the electronic machine now being designed at the Institute under Dr. Harry D. Huskey. Interested engineers, physicists, and mathematicians throughout the nation are invited to this symposium, which is tentatively planned for June 24–25.

The second symposium will cover probability methods in numerical analysis, with emphasis on applications of the Monte Carlo method that has proved so useful in the solution of many problems in mathematical physics. This symposium is being arranged jointly by the Institute and the Rand Corporation with the assistance of the Atomic Energy Commission. It is tentatively planned for June 27–29.

Further information regarding either symposium or both may be obtained from Dr. J. H. Curtiss, Institute for Numerical Analysis, Los Angeles 24, Calif.

Materials-Handling Bridges

Conference on Electrical Equipment for Materials-Handling Bridges sponsored by the Cleveland Section and the Subcommittee on Materials Handling of the American Institute of Electrical Engineers, will be held in the Hotel Cleveland, Cleveland, Ohio, May 13, 1949.

The program will consist of two papers, one on electrical design practices on direct-current materials-handling bridges, and the other on adjustable voltage drives for ore bridges and unloaders. A forum session will follow during which bridge builders, equipment manufacturers, and users will discuss questions raised by the conference group on electric installations for bridges. Registration fee of $3 including price of luncheon will be charged.

Paris Industrial Exposition

The annual Paris Fair, one of the largest of the European industrial expositions, will be held May 21-June 6, 1949. Nearly 10,000 exhibitors will participate, showing almost every phase of heavy and light industry.

Established in 1904, the Paris Fair has grown physically and in prestige throughout its 45-year history. The fair utilizes 125 acres of space. Its central thoroughfare, almost a mile long, is serviced by its own trolley system.

Industrial products, ranging from locomotives, aircraft, and machine tools to textiles, fashion items, and household goods, are elaborately displayed by their manufacturers in halls and permanent buildings on the Fair grounds. Special areas are devoted to various classifications of products, with special buildings set aside for inventors' products and colorful handicrafts.

Wood Symposium

A two-day symposium on wood, covering topics ranging from wood supply to utilization, sponsored by the National Research Council and the Office of Naval Research is to be held at the National Academy of Sciences, Washington, D. C., in June, 1949.

Meetings of Other Societies

May 9–12
The American Mining Congress, coal-mining convention and exposition, Public Auditorium, Cleveland, Ohio

May 11–13
The Engineering Institute of Canada, annual meeting, Chateau Frontenac, Quebec, Can.

May 12–13
The Society of Naval Architects and Marine Engineers, 1949 spring meeting, Palace Hotel, San Francisco, Calif.

May 19–21
Society for Experimental Stress Analysis, spring meeting, Hotel Statler, Detroit, Mich.

May 23–27
Smoke Prevention Association of America, annual meeting, Tutwiler Hotel, Birmingham, Ala.

May 25–26
American Iron and Steel Institute, general meeting, New York, N. Y.

June 5–9
The American Society of Refrigerating Engineers, 36th spring meeting, SS *Richelieu*, St. Lawrence-Saguenay Cruise

June 5–10
Society of Automotive Engineers, Inc., summer meeting, French Lick Springs Hotel, French Lick Springs, Ind.

June 6–8
American Gear Manufacturers Association, annual meeting, The Homestead Hotel, Hot Springs, Va.

June 6–9
American Petroleum Institute, standardization committee on the division of production meeting, Baker Hotel, Dallas, Texas

June 20–24
American Society for Engineering Education, annual meeting, Rensselaer Polytechnic Institute, Troy, N. Y.

June 20–24
American Institute of Electrical Engineers, summer general meeting, New Ocean House, Swampscott, Mass.

(*For ASME Coming Events see page 449*)

Sessions tentatively scheduled include discussions of the mechanical and physical properties of wood, the chemistry of wood, and its biological deterioration. Scientists doing research in these fields of wood study will address the sessions. The symposium is part of the program administered by the Office of Naval Research to find more and better supplies of wood for Naval applications.

Aerodynamics

The Naval Ordnance Laboratory aeroballistics facilities including supersonic and hypersonic wind tunnels and transonic and pressurized ballistics ranges, at White Oak, Md., will be formally dedicated on June 27, 1949.

The formal dedication will be followed, June 27–29, by five half-day technical sessions on general aerodynamics, ordnance aeroballistics (restricted), theoretical supersonic and transonic aerodynamics, and experimental supersonic aerodynamics. United States and foreign scientists have been invited to present papers.

In connection with the dedication and technical sessions, the Fluid Dynamics Division of the American Physical Society will meet at the Naval Ordnance Laboratory on June 30 and July 1. There will be symposiums on turbulence, shock-wave phenomena, and aerothermodynamics, in addition to contributed papers.

Persons interested in attending the dedication and technical sessions of June 27–29 should address requests for invitations to Naval Ordnance Laboratory, attention Dr. R. J. Seeger.

Instruments

The exhibits in the Fourth National Instrument Exhibit to be held in the St. Louis Municipal Auditorium, Sept. 12–16, 1949, are expected to equal last year's record.

Technical sessions of the Instrument Society of America, American Institute of Physics, Industrial Instruments and Regulators Division of The American Society of Mechanical Engineers, and the Instruments and Measurements Committee of the American Institute of Electrical Engineers, the Institute of Radio Engineers, the American Institute of Chemical Engineers, and the National Telemetering Forum, will be held in the Auditorium.

Industrial Water Problems

The Tenth Annual Water Conference of the Engineers' Society of Western Pennsylvania will be held in the Hotel William Penn, Pittsburgh, Pa., Oct. 17–19, 1949.

Among the topics to be discussed during the six sessions will be: how to solve waste-disposal problems in a large industry; problems of generating pure steam at high pressures; deaerating feedwater-heater problems; chemical-feed systems; and others.

Industrial Hydraulics

The fifth annual National Conference on Industrial Hydraulics will be held Oct. 26–27, 1949, at the Sheraton Hotel, Chicago, Ill. The conference will be sponsored by the Armour Research Foundation of Illinois Institute of Technology and the Graduate School of the Institute, with the co-operation of Chicago sections of seven national engineering societies.

Otto J. Maha, vice-president, Hannifin Corporation, Chicago, Ill., is serving as conference director, and Sidney F. Musselman, Mem. ASME, applied mechanics department, Armour Research Foundation, is conference secretary.

This two-day annual conference is devoted to serving all engineers in the field of industrial hydraulics through the presentation of technical papers by authoritative speakers.

Quality Control

Four clinic series of five sessions each will be featured at the Third Annual Convention of the American Society for Quality Control to be held at the Copley Plaza Hotel, May 5–6, 1949. Topics will be: Quality Control Engineering; Management's Problems of Quality; Advanced Techniques; and Selected Topics of Special Interest.

Engineering Structures

The College of Engineering of the University of Michigan is sponsoring a symposium on engineering structures during the summer session of 1949. The guest professors for this program are: S. P. Timoshenko of Stanford University, and Sir R. V. Southwell of the Imperial College of Science and Technology, London, England.

The following program will be offered: Professor Timoshenko will give a course in theory of plates and shells. Professor Southwell will offer a course in relaxation methods with application to aircraft structures.

This program will also include advanced courses in: Vibrations, plasticity, dynamics, theory of structures, theory of rigid frame structures, elasticity, photoelasticity, limit design, thermodynamics, and history of dynamics. The mathematics department will offer an extensive program in applied mathematics.

Awards

THE Washington Award for 1949 was conferred recently on John Lucian Savage, consulting engineer for the Tennessee Valley Authority and the U. S. Bureau of Reclamation, in recognition of his unselfish public service devoted to the creation of 300 dams in the United States and in 15 foreign countries. The award was presented at the annual Washington Award Dinner held in Chicago, Ill., April 20, 1949. Forrest Nagler, vice-president, ASME Region VI, represented The American Society of Mechanical Engineers at the ceremony.

Mr. Savage had immediate charge of design specifications and construction-cost estimates of the Yangtze River Dam, one of the most unusual in the world. This dam is to be 25 ft higher than the Boulder Dam and is designed to control the Yangtze River to permit the movement of 10,000-ton seagoing vessels between Shanghai and Chungking.

The award is conferred annually by The Western Society of Engineers on recommendation of a commission of awards composed of representatives of the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, American Institute of Electrical Engineers, and The Western Society of Engineers.

L. J. FISHER, Mem. ASME, was among the fifty-five members of the General Electric Company and its affiliated companies to receive the Charles A. Coffin Award for work of outstanding merit during 1948. Mr. Fisher's citation read:

"In recognition of his outstanding work, in collaboration with William O. Meckley, in the design, promotion, and development of a highperformance reciprocating engine and turbosupercharger cycle, as incorporated in the variable-discharge turbine power installation for aircraft."

* * *

THE 1948 Lamme Medal of the American Institute of Electrical Engineers has been awarded to V. K. Zworykin, vice-president and technical consultant, RCA Laboratories Division, Radio Corporation of America, Princeton, N. J., "For his outstanding contribution to the concept and design of electronic apparatus basic to modern television."

The medal will be presented to Dr. Zworykin at the Summer General Meeting of the Institute to be held in Swampscott, Mass., June 20-24, 1949.

The Lamme Medal was established through a bequest of Benjamin Garver Lamme, who was chief engineer of the Westinghouse Electric and Manufacturing Company from 1903 to his death in 1924. Beginning in 1928, the medal has been awarded annually for high achievements in the development of electric apparatus or machinery.

Education

ASEE Annual Meeting to Be Held June 20–24, 1949

THE theme of partnership with industry will keynote the 1949 annual meeting of the American Society for Engineering Education to be held June 20-24, 1949, at Rensselaer Polytechnic Institute, Troy, N. Y.

Twenty-five hundred presidents, deans, and professors of leading engineering colleges, scientists, and industrial leaders will attend the conference. The meeting will coincide with Rensselaer's 125th anniversary celebration.

Presentation of the Lamme Medal and the Westinghouse Award to the recipients for meritorious achievement in the teaching profession will highlight the five-day sessions. Delegates also will take side trips to industrial plants in the Troy-Albany-Schenectady area. An international conference on engineering education will feature engineering educators from all over the world. The Engineering College Research Council of the ASEE will feature a program on instrumentation for engineering research, and the Engineering College Administrative Council will have special programs dealing with education in the field of atomic energy, secondary-school developments, and selective-service problems. The program will include approximately 150 papers presented by leaders in the educational field dealing with various aspects of engineering education.

The ASEE annual meeting will be followed by the 1949 Summer School for Mechanical Engineering Teachers sponsored jointly by the ASEE and The American Society of Mechanical Engineers. The program for the summer school covers such topics as teaching methods, professional development of instructors, presentation of subject matter for general and specialized courses, integration of the curriculum, professional development of the student and his preparation for the first job. A series of social events is also planned.

SPE Proposes Plastics Courses

THE integrated program of professional engineering education in plastics has been prepared by The Society of Plastic Engineers, Athens, Ohio, to acquaint the teaching profession with opportunities in the new field of plastics, and to provide a guide for the training of mechanical, electrical, and chemical engineers for professional engineering careers in the plastics industry.

The program, described in a brochure prepared by SPE Educational Committee composed of representatives of industry and engineering educators, suggests two introductory courses for the undergraduate curriculum and five graduate courses. The courses, which cover high-polymer chemistry, properties of plastics, electrical measurements, plastics designing, and chemical engineering of high polymers, are designed to provide engineers required by the plastics industry itself, while the undergraduate courses aim to give young engineers useful supplementary knowledge of plastics materials.

With the phenomenal growth of the plastics industry and the increasing applications of plastics, it was evident to the committee that engineers in future will have increasing contact with plastics as an engineering material. At the present time there is no source of engineers trained for the special field of plastics, and industry has had to depend on self-training and extension courses for the training of its men. While the results have been moderately successful, the committee felt that a broad fundamental training at an educational institution would provide most benefits to the individual and the industry. The program therefore provides for general plastics training required by the manufacturing industries using plastics, and the specific training needed by the plastics industry itself.

Management-Labor Scholarships

THE Joint Industry Board of the Electrical Industry, representing both management and labor, has announced a broad program to provide two five-year scholarships annually at Columbia University to sons of electricians who are members of Local Union No. 3 of the International Brotherhood of Electrical Workers. Each scholarship, amounting to $4200, will be in electrical engineering and will cover full tuition, books, and fees. At the end of five years the Board will be sponsoring 10 students. The scholarships, which are to be continued indefinitely, are believed to be the first in which management and labor have joined to create educational opportunities for boys of ability.

People

ROBERT B. DOUGLAS, president, Godscroft Industries Ltd., Montreal, Ont., Can., was elected president of the American Society of Tool Engineers at their annual meeting held recently in Pittsburgh, Pa.

* * *

EDWIN J. SCHWANHAUSSER, Mem. ASME, vice-president in charge of sales, Worthington Pump and Machinery Corporation, was elected recently to the board of trustees of Stevens Institute of Technology.

* * *

JAMES W. PARKER, past-president and Hon. Mem. ASME, has been appointed special consultant to the U. S. Military Governor for Germany, Gen. Lucius D. Clay, to examine the critical power situation in Western Germany. Mr. Parker left for Germany in March, taking with him as assistants, George P. Steinmetz, chief engineer, Public Service Commission of Wisconsin, and Alois Hoefle, assistant superintendent of operations, Toledo Edison Company. The group is expected to return some time this month.

* * *

GEORGE A. STETSON, Fellow ASME, and editor of MECHANICAL ENGINEERING, received an honorary degree of doctor of science from the Rose Polytechnic Institute, Terre Haute, Ind., April 23, 1949.

* * *

THREE ASME members were among the engineers honored with Distinguished Service Citation Awards at the Engineers' Centennial Day Dinner sponsored by the dean and faculty of the University of Wisconsin, College of Engineering, as part of the centennial anniversary of the University. They are Leroy F. Harza, Louis R. Howson, and James F. Roberts.

* * *

WILLIAM C. FOSTER, Mem. ASME, currently serving the Economic Co-operation Administration as deputy U. S. Special Representive in Europe, has been given the rank of ambassador in the State Department by President Harry S. Truman. Mr. Foster is one of the ASME representatives on the Committee on International Relations of the Engineers Joint Council.

* * *

THE first master's degree in mechanical engineering awarded to a woman by Illinois Institute of Technology, was recently conferred on Lois Graham, Jun. ASME. She intends to teach at the Institute while working toward a doctorate.

ASME NEWS

Excellent Program Planned for ASME 1949 Semi-Annual Meeting

Theme: Engineering Frontiers

THE 1949 Semi-Annual Meeting of The American Society of Mechanical Engineers will be held at the University of California Extension Building, San Francisco, Calif., June 27–July 1, 1949. A program of technical sessions based on the theme, "Engineering Frontiers," a series of carefully planned luncheons and dinners, and field trips to points of interest will set off for visitors the industrial and cultural achievements of San Francisco.

Registration will commence on Sunday, June 26. In the afternoon members will be entertained by the San Francisco Section at a picnic to be held in the famous Muir Woods. This will include a drive over the Golden Gate Bridge and along San Francisco Bay.

With the arrival of the special tour train from the east, the technical program will begin. During the mornings of each day, Monday through Friday, technical sessions, committee meetings, and other Society business will be conducted. Afternoons have been left free to permit members to participate in tours and inspection trips.

The technical program consists of 27 sessions. The full program appears in the following pages. All technical sessions will be held in the University Extension Building.

Many Field Trips Scheduled

During the afternoons, Robert W. Roth, field-trip chairman, has arranged for the following excursions. The Monday afternoon field trips will be to the Hunters Point Naval Repair Depot, where the world's largest crane installation is situated and where a number of battleships and carriers of the Pacific Fleet are always docked, and a boat ride in San Francisco Bay.

On Tuesday field trips will be offered to the world's largest cyclotron, located at the University of California, and to the United Air Lines Maintenance Base, South San Francisco.

On Thursday an excursion to Ames Aeronautical Laboratory, fifty miles below San Francisco, will provide an opportunity to inspect a modern experimental aeronautical establishment, together with its enormous supersonic wind tunnel and other features which make Ames one of the most advanced aeronautical research centers in the world today.

On Thursday afternoon, also, a field trip is offered to Station "P" of the Pacific Gas and Electric Corporation where generating equipment of unusual interest is installed, and to Santa Clara University.

Luncheons

Each of the field trips has been co-ordinated with the entertainment features, dinners, and luncheons. Beginning on Monday noon the delegates will assemble at the Aquatic Park on San Francisco Bay. Here luncheon will be served and the guests will be officially welcomed to the City. During the afternoon those registered for the Hunters Point trip will be transported thence by boat, having opportunity to view the Bridges, Alcatraz, Treasure Island, and the waterfront en route. Guests not wishing to go to Hunters Point will be provided with a short sight-seeing trip by boat during the afternoon, and will have an opportunity to inspect Fisherman's Wharf or the Presidio, and to swim at the Aquatic Park if they please. Shortly after the boat returns from Hunters Point, supper will be served at the Park Pavilion; and later in the evening a trip through Chinatown is planned.

On Tuesday luncheons are to be provided at the University of California and the United Air Lines Cafeterias for those going on the field trips to these places, respectively. In the evening, delegates will assemble for a dinner at the famous Claremont Hotel in Berkeley, where Rex Nicholson will speak on "Industrial and Agricultural Development of the West."

On Thursday luncheon is to be arranged at some spot on the San Francisco peninsula, after which the ladies are to be driven to Santa Clara University, to have tea at the Mission while the men visit Ames. Dinner is to be at Stanford University, and a tour of the campus will be featured as part of the evening's entertainment.

Women's Program

In addition to the tour of the peninsula on Thursday, many interesting events have been especially arranged for the women by Mrs. Robert Sibley and Alf Hansen, jointly in charge of women's events. On Monday the women will join in the fun radiating from Aquatic Park. On Tuesday they will be driven through the Berkeley hills to wind up at the Claremont for dinner. Many shopping trips and other special attractions are also being scheduled.

Banquet at Palace Hotel

As usual, the high light of the meeting will be Wednesday, with the banquet which is to be held at the famous Palace Hotel in San Francisco, with its many grand associations going back into the last century, and now particularly highlighted by the 1949 celebration which makes this a festive summer in California. The San Francisco Local Committee found it necessary to schedule the banquet at the Palace Hotel instead of the Fairmont Hotel.

Both afternoon and evening programs are to be under the chairmanship of Robert Sibley. During the afternoon an International Engineering Seminar will present prominent personalities from many foreign countries, and will follow the theme, "International Understanding Through Science and Engineering."

The banquet speaker will be Pres. Robert Sproul of the University of California, who is an engineer. He will carry forward the international theme. James M. Todd, presi-

SAN FRANCISCO BAY BRIDGE AS SEEN FROM YERBA BUENA ISLAND dent ASME, will also speak. Professor Sibley will be toastmaster.

The local committees have prepared a fine program which will be not only up to a high technical standard, but which will provide abundant entertainment, general interest, many happy experiences, gastronomic adventures, and other features to mark this event as one not to be missed.

Tentative Program

MONDAY, JUNE 27

8:00 a.m.

Registration

9:00 a.m.

Applied Mechanics (I)

Atomization of Liquids by Means of a Rotating Cup, by J. O. Hinze and H. Milborn, Delft Laboratory, Royal Dutch Shell Group, Delft, Holland

Performance of the Viscously-Damped Vibration Absorber Applied to Systems Having Frequency-Squared Excitation, by Fred M. Sauer, instructor in mechanical engineering, and Clyne F. Garland, associate professor of engineering design, University of California, Berkeley, Calif. (49—SA-5)

Free Periodic Motions of an Undamped Two-Degrees-of-Freedom Oscillatory System With Nonlinear Unsymmetric Elasticity, by W. W. Soroka, associate professor of engineering design, University of California, Berkeley, Calif. (49—SA-6)

Gas Turbine Power (I)—Aviation (I)

The Gas Turbine Regenerator—The Use of Compact Heat Transfer Surfaces, by A. L. London, professor of mechanical engineering, and W. M. Kays, acting instructor, mechanical-engineering department, Stanford University, Stanford University, Calif. (49—SA-9)

Aircraft Gas Turbine Installation Considerations, by Benjamin T. Salmon, design group engineer, Consolidated Vultee Aircraft Corporation, San Diego, Calif.

Turbojet-Engine Installation Problems, by W. H. Hand, power-plant test engineer, North American Aviation, Inc., Los Angeles, Calif.

Petroleum (I)

Practical Aspects of Orifice-Meter Calculations, by H. A. Jacobson, Shell Development Company, San Francisco, Calif.

Mechanical Vibration of Piping Induced by Gas-Pressure Pulsations, by Ira C. Bechtold, director of research, and R. C. Baird, research engineer, The Fluor Corporation, Ltd., Los Angeles, Calif.

Hydraulic

History and Development of the Grand Coulee Pumping Plant, by E. B. Moses, engineer, hydraulic equipment, Bureau of Reclamation, Denver, Colo.

Development of the Hydraulic Design for the Grand Coulee Pumps, by Carl Blom, chief engineer, Byron Jackson Company, Huntington Park, Calif. (49—SA-8)

Mechanical Design and Construction of Grand Coulee Pumps, by I. M. White, chief engineer, Pelton Water Wheel Company, San Francisco, Calif.

ASME National Nominations

THE 1949 Nominating Committee invites members to appear at its open meeting June 28, 1949, at the University of California Extension Division Building, 540 Powell Street, San Francisco, California, where the Semi-Annual Meeting will be held. Members may present their views concerning candidates for the office of President, Regional Vice-President, and Director at Large any time between the hours of 10 a.m. to 12 noon; and 2 p.m. to 4 p.m.

Predesign Investigations for the Grand Coulee Pumping Plant, by G. J. Hornsby, engineer, Bureau of Reclamation, Denver, Colo.

Metals Engineering

The Effect of Metallic Coatings on the Endurance Limit of Steel, by R. R. Moore, metallurgist, Naval Aircraft Factory, Naval Base Station, Philadelphia, Pa.

Surface-Finish Requirements in Design, by J. A. Broadston, North American Aviation, Inc., Englewood, Calif.

The Forming of a Plastic Sheet Between Fixed Cylindrical Surfaces With Coulomb Friction, by H. I. Ansoff, graduate student, Brown University, Providence, R. I.

12:30 p.m.

Welcoming Luncheon

2:30 p.m.

Inspection Trips

Boat Ride in San Francisco Bay
Hunters Point Naval Repair Depot

6:30 p.m.

Dinner

TUESDAY, JUNE 28

9:00 a.m.

Applied Mechanics (II)

Beam-Vibration Analysis With the Electric-Analog Computer, by G. D. McCann, professor of electrical engineering, and R. H. McNeal, California Institute of Technology, Pasadena, Calif. (49—SA-3)

Transverse Vibration of a Two-Span Beam Under the Action of a Moving Constant Force, by R. S. Ayre, acting associate professor, mechanical engineering, Stanford University, Stanford University, Calif.; G. Ford, assistant professor of civil engineering, University of Alberta, Edmonton, Canada; and L. S. Jacobsen, professor of mechanical engineering, Stanford University, Stanford University, Calif. (49—SA-4)

The Behavior of Long Beams Under Impact Loading, by P. Duwez, associate professor of mechanical engineering, D. C. Clark, associate professor of mechanical engineering, and H. F. Bohnenblust, professor of mathematics, California Institute of Technology, Pasadena, Calif. (To be presented by Title) (49—SA-1)

Critical Loads of Columns of Varying Cross Section, by W. T. Thomson, associate professor of mechanics, University of Wisconsin, Madison, Wis. (49—SA-2)

Gas Turbine Power (II)—Aviation (II)

A Comparison of Turboprop and Turbojet Engines at Elevated Temperatures and Pressures, by E. L. Hunsaker, aerothermo division head, and E. I. Brown, thermodesign engineer, The Turbodyne Corporation, Hawthorne, Calif.

Design of Heat Exchangers for the Regenerative-Cycle Aircraft Turboprop Engine, by F. E. Romie and A. G. Guibert, associate engineers, and C. D. Coulbert, junior engineer, department of engineering, University of California, West Los Angeles, Calif.

Petroleum (II)

Design of the Trans-Arabian Pipe Lines, by S. P. Johnson, Standard Oil Company of California, San Francisco, Calif.

Synthetic Liquid Fuels From Coal and Oil Shale, by W. C. Schroeder, chief, office of synthetic liquid fuels, Bureau of Mines, Washington, D. C.

9:00 a.m.

Railroad

Cosponsored by Pacific Railway Club and AIEE San Francisco Section

(Papers to appear in final program)

Industrial Instruments and Regulators (I)—Power (I)

Measurement and Control System for Engines, by C. S. Draper, professor of aeronautical engineering, and Y. T. Li, research associate, Massachusetts Institute of Technology, Cambridge, Mass.

Instrumentation for an Atomic Power Plant, by David Cochran, division engineer, Knolls Atomic Power Laboratory, General Electric Company, Schenectady, N. Y.

9:00 a.m.

Boiler Feedwater Studies—Power (II)

Limitations in the Use of Sodium Sulphite for Oxygen Control in Boiler Feedwater, by R. C. Alexander, mechanical engineer, Harbor Steam Station, Los Angeles Department of Water and Power, Wilmington, Calif., and H. K. Rummel, chemical and consulting engineer, Baltimore, Md.

Official Notice

ASME Business Meeting

THE Semi-Annual Business Meeting of the members of The American Society of Mechanical Engineers will be held on Monday morning, June 27, 1949, in the University of California Extension Building, San Francisco, Calif., as part of the Semi-Annual Meeting of the Society.

Symposium: Experience in Chemical Control in Preboiler Water Systems of Central Stations on the Pacific Coast With Special Reference to Early Operations.

Speakers: Jens Scott Jensen, steam-plant engineer, Redondo Steam Plant, Southern California Edison Company, Los Angeles, Calif.; C. L. Hathaway, superintendent of electric production, San Diego Gas and Electric Company, San Diego, Calif.; R. C. Alexander, mechanical engineer, Harbor Steam Station, Los Angeles Department of Water and Power, Wilmington, Calif.; and Henry Kehmna, chemical engineer, Pacific Gas and Electric Company, San Francisco, Calif.

12:30 p.m.

General Luncheon

2:30 p.m.

Inspection Trips

Visit to cyclotron in Berkeley, Calif.
United Air Lines Maintenance Base

6:00 p.m.

Dinner

Industrial and Agricultural Development of the West, by Rex Nicholson

WEDNESDAY, JUNE 29

9:00 a.m.

Power (III)

Industrial Power Plant—Weyerhaeuser Timber Company, by C. Dodge, assistant chief engineer, Weyerhaeuser Timber Company, Tacoma, Wash., and C. W. E. Clarke, vice-president and consulting engineer, United Engineers and Constructors, Philadelphia, Pa.

History and Performance of Pacific Gas and Electric Company's Oil Refinery Steam-Electric Generating Stations, by V. F. Estcourt, engineer of steam and gas operation, Pacific Gas and Electric Company, San Francisco, Calif. (49—SA-11)

9:00 a.m.

Production Engineering (I)

A Survey of Different Milling Methods With Special Regard to the Forces Developed, by Andrew Hornung, consulting engineer, Ganz & Company, Budapest, Hungary. Presented by R. A. Galuzevski, instructor in mechanical engineering, University of California, Berkeley, Calif.

Engineering for Production, by Carl Beach, assistant sales manager, Cincinnati Milling Machine Company, Cincinnati, Ohio.

9:00 a.m.

Machine Design (I)

Nomographic Solutions of Machine-Design Problems, by F. R. Berry, Jr., lecturer, University of California, Berkeley, Calif.

Experimental Aids in Engineering-Design Analysis, by Walter W. Soroka, associate professor, University of California, Berkeley, Calif.

9:00 a.m.

Industrial Instruments and Regulators (II)

Uses of Strain-Sensitive Wire in Instrumentation, by Richard D. Meyer, physicist, Statham Laboratories, Inc., Beverly Hills, Calif.

Electrical Pickoffs for Pilotless Aircraft Instruments, by Jack Andresen, project engineer, Kollsman Instrument Division, Square D Company, Elmhurst, N. Y.

9:00 a.m.

American Rocket Society

(Papers to appear in final program)

12:30 p.m.

General Luncheon

2:30 p.m.

Inspection Trip

6:30 p.m.

Banquet

Toastmaster: Robert Sibley, executive manager, University of California Alumni Association, Berkeley, Calif.

President's Address: James M. Todd, president, ASME

Speaker: Robert Sproul, president, University of California, Berkeley, Calif.

THURSDAY, JUNE 30

9:00 a.m.

Power (IV)

Steam-Electric Power Expansion in Southern California, by W. L. Chadwick, manager of engineering department, Southern California Edison Company, Los Angeles, Calif.

Postwar Planning for Steam Capacity in Northern California, by C. C. Whelchel, chief, division of steam engineering, and W. R. Johnson, division of hydroelectric and transmission engineering, Pacific Gas and Electric Company, San Francisco, Calif.

Summary of the following four papers, by H. E. White, mechanical engineer, Stone and Webster Engineering Corporation, Boston, Mass.

Fundamentals of Marine Fouling, by W. F. Clapp, marine biologist, William F. Clapp Laboratories, Inc., Duxbury, Mass.

Project Study for the Mitigation of Marine Growth, by I. A. Patten, general superintendent, Lynn Gas and Electric Company, Lynn, Mass. (49—SA-20)

Control of Marine Fouling in Sea-Water Conduits and Cooling-Water Systems Including Exploratory Tests on Killing Shelled Mussels, by H. E. White, mechanical engineer, Stone and Webster Engineering Corporation, Boston, Mass. (49—S-12)

Control of Marine Fouling by Temperature at Redondo Steam Station, by W. L. Chadwick, manager of engineering department, Southern California Edison Company, Frank S. Clark, consulting engineer, Stone and Webster Engineering Corporation, Los Angeles, Calif., and D. L. Fox, professor of marine biochemistry, Scripps Institution of Oceanography, division of the University of California, La Jolla, Calif. (49—S-13)

9:00 a.m.

Fuels (I)

Cylindrical Furnaces for the Petroleum Industry, by O. F. Campbell, combustion engineer, Sinclair Refining Company, East Chicago, Ind. (49—SA-12)

Some Recent Developments in Burning Wet Wood, by Otto de Lorenzi, director of education, Combustion Engineering-Superheater Company, Inc., New York, N. Y.

9:00 a.m.

Production Engineering (II)

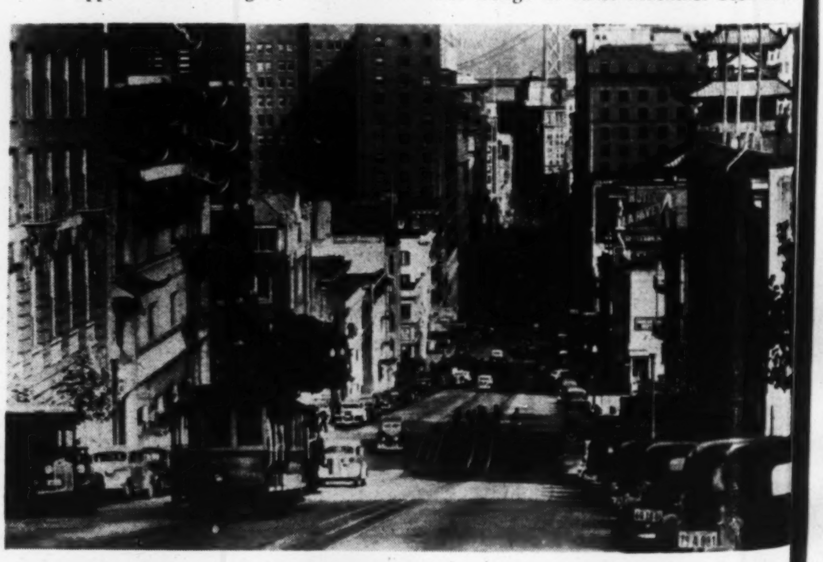
The Manufacturing Problems of the Contract Machine Shop, by Jule H. Coffey, president, Peacock Machine Company, Los Angeles, Calif.

Automation, by Nevin L. Bean, director, production engineering, Ford Motor Company, Detroit, Mich.

9:00 a.m.

Machine Design (II)

The Design of Office Machines Such as Cal-



CALIFORNIA STREET, SAN FRANCISCO, SHOWING ONE OF THE FAMOUS CABLE STREETCARS culators, by Harold T. Avery, chief engineer, Marchant Calculating Machine Company, Oakland, Calif.

Factors Affecting the Selection and Application of High-Pressure Pumps, Valves, and Fluid Motors, by H. Vickery, The Rucker Company, Oakland, Calif.

9:00 a.m.

Management (I)

Management Problems in the Growth of Regional Industries, by Graham W. Parker, industrial consultant, New York, N. Y.

Production Management in Small Business, by Frank K. Shallenberger, associate professor of industrial management, graduate school of business, Stanford University, Stanford University, Calif.

Have Wage Incentives Been Oversold? by Douglas Watson, associate, McKinsey and Company, San Francisco, Calif.

9:00 a.m.

Education

(Papers to appear in final Program)

12:30 p.m.

General Luncheon

2:30 p.m.

Inspection Trips

Visit to San Jose (Food Machinery)
Santa Clara University
Ames Aeronautical Laboratory
Station "P," Pacific Gas and Electric Company

6:30 p.m.

Dinner

FRIDAY, JULY 1

9:00 a.m.

Power (V)

The Design of Sewaren Generating Station and No. 1 Unit at Essex Station of Public Service Electric and Gas Company, by F. P. Fairchild, chief engineer, electric-engineering department, Public Service Electric and Gas Company, Newark, N. J.

Operating Characteristics of the 100,000-Kw Essex Turbine Generator, by Stanford Neal, section engineer, steam-turbine engineering division, General Electric Company, Schenectady, N. Y., and V. S. Renton, engineer, Public Service Electric and Gas Company, Newark, N. J.

Heat Rate Test Results of the 100,000-Kw Essex Turbine Generators, by Stanford Neal, section engineer, steam-turbine engineering division, General Electric Company, Schenectady, N. Y., and V. S. Renton, engineer, Public Service Electric and Gas Company, Newark, N. J.

9:00 a.m.

Fuels (II)

Panel Discussion: Coal for West Coast Power Generation

9:00 a.m.

Management (II)

The Human Factors in the Design of Manual Machine Controls, by Louis E. Davis, assistant professor of mechanical engineering, University of California, Berkeley, Calif.

Optimum Speeds of Indexing Devices, by D. G. Malcolm, lecturer on mechanical engineering, University of California, Berkeley, Calif.

9:00 a.m.

Oil and Gas Power

Two-Cycle Dual-Fuel Diesel Engine With Automatic Fuel Conversion, by E. L. Conn, R. H. Beadle, and G. A. Schauer, research staff, Fairbanks, Morse and Company, Beloit, Wis.

Ignition System for Oil Engines, by H. B. Holthouse, Holthouse Laboratory, Chicago, Ill.

The Ignition of Diesel Fuel—Iso-Amyl-Nitrate Mixtures at Atmospheric Pressure, by A. Boodberg and I. Cornet, professors, University of California, Berkeley, Calif.

9:00 a.m.

Process Industries

(Papers to appear in final program)

12:30 p.m.

General Luncheon

Special Tour Planned to ASME Semi-Annual Meeting

NINETY members of The American Society of Mechanical Engineers and their wives have expressed interest in taking the special personally conducted tour to the ASME Semi-Annual Meeting to be held in San Francisco, Calif., June 27–July 1, 1949. The itinerary is now in completed form as the negotiations are under way with these members to provide them with the exact kind of accommodations they wish.

The tour will include stops at the Grand Canyon National Park, the 200-in. telescope at Mt. Palomar, Los Angeles, the Redwood Forests, Yosemite National Park, Mt. Rainier National Park, Yellowstone National Park, Seattle, Shasta Dam, and other points.

The tour will leave New York June 18, 1949, and arrive in San Francisco on June 27 in time for the Semi-Annual Meeting. After the meeting the tour will continue to Shasta Dam, Portland, Mt. Rainier, and Yellowstone National Parks, and return to New York, July 14.

From New York the price of the tour ranges from $632.50 to $732.50 according to accommodations. From Chicago prices begin at $535 for an upper berth and range to $614 for two persons in a drawing room.

Comfortable accommodations, complete relief from baggage, schedules, tickets, and other details, and above all, the ASME bond of good fellowship, will add to the pleasure of sight-seeing.

Members who have not previously expressed an interest are encouraged immediately to write to the Secretary in order to obtain full information and to complete arrangements.

For Retired Engineers

THE Old Guard Committee of The American Society of Mechanical Engineers is preparing a list of lecturers composed of retired ASME members who have expressed willingness to lecture at engineering schools on current problems in their special fields of interest.

Since the project was first announced in the February issue, more than 15 members have signed up as lecturers.

If you want to participate in the project write to the Old Guard Committee, ASME, 29 West 39th Street, New York 18, N. Y.

Industrial Engineering Topic at Piedmont Section Meeting

MORE than a hundred and fifty members and guests attended an all-day meeting of the Piedmont Section of The American Society of Mechanical Engineers held at the Robert E. Lee Hotel in Winston-Salem, N. C., on March 4, 1949. The program was sponsored by the Western Electric Company which has several large plants in the Winston-Salem area, and all of the speakers were from the engineering staff of that manufacturer of electrical and electronic equipment. With but one exception all of the papers presented in the full-day session were devoted to various phases of industrial engineering.

Similar full-day sessions devoted largely to one phase of engineering work have been held several times by the Piedmont Section at one to two-month intervals. They have attracted wide attention within the region and have drawn members from even the most distant towns. Much of the success of the meetings may be attributed to the planning and enthusiasm of Mebane E. Turner, mechanical engineer, R. J. Reynolds Tobacco Company, who is chairman of the Section.

C. W. Reynolds, superintendent of manufacturing engineering for Western Electric, presided at the sessions which started at 9 a.m. R. E. Frank then presented a paper on wage surveys in which he told how the radio shops established wage rates in a new location by using a survey of comparable rates in the geographic area. R. W. Gruoenhof discussed job evaluation, describing his company's plans, administration problems, and their engineers' responsibilities.

Three other papers were presented in the morning session and three in the afternoon session.

After the presentation of the last afternoon paper, members and guests made an inspection trip of the Western Electric plant and were shown a radar unit in action. The unit demonstrated was one of those to be used by heavy shipping on the Great Lakes.

T. J. Grieser, mechanical-development engineer, Bell Telephone Laboratories, was the speaker at the after-dinner session.

Program for the Fifteenth ASME Applied Mechanics Conference, June 13–15

Headquarters: University of Michigan, Ann Arbor, Mich.

THE Fifteenth Applied Mechanics Conference sponsored by the Applied Mechanics Division of The American Society of Mechanical Engineers will be held at the H. A. Rackham School of Graduate Studies, University of Michigan, Ann Arbor, Mich., June 13–15, 1949.

Six Sessions

The technical program will consist of six technical sessions at which 29 papers on such subjects as vibrations, plasticity, hydrodynamics, and stress analysis will be presented. The morning session of Wednesday, June 15, will consist of a symposium on applied mathematics sponsored jointly by the ASME and the American Mathematical Society. Several luncheons and a banquet are planned as part of the conference. A lawn party during the evening of the second day of the conference will be held for the delegates.

At the banquet planned for Monday, June 13, J. A. Perkins, assistant provost, University of Michigan, will address the conference on "The Underpinning of Education."

Arrangements have been made to accommodate delegates in the Michigan Union and the West Quadrangle Dormitory. In the Michigan Union single rooms range from $3 to $3.50, and double rooms from $6.50 to $7.50. Single rooms in the West Quadrangle Dormitory are priced at $2, and double rooms at $1.50 per person. Members are urged to write for reservations to Prof. E. L. Ericksen, University of Michigan, Ann Arbor, Mich.

Preprints Available

For the benefit of members who would like to discuss papers to be presented at the conference, the ASME has preprinted most of the papers on the program. Preprints should be ordered by the code numbers which appear after titles in the program which follows. Members are urged to read papers before they depart for Ann Arbor. Price of preprints is 25 cents each to members, and 50 cents to nonmembers. Copies may be obtained from ASME Publication-Sales Department, 29 West 39th Street, New York 18, N. Y.

The program follows:

MONDAY, JUNE 13

9:30 a.m.

Session I

Bending Vibration of a Rotating Blade Vibrating in the Plane of Rotation, by R. L. Sutherland, assistant professor of mechanical engineering, The State University of Iowa, Iowa City, Iowa. 49—APM-6

On One-Term Approximations of Forced Nonharmonic Vibrations, by G. Schwesinger, consultant, Signal Corps Engineering Laboratory, Fort Monmouth, N. J. 49—APM-17

Vibration of Multifrequency Systems During Acceleration Through Critical Speeds, by G. D. McCann, professor of electrical engineering, and R. R. Bennett, teaching assistant, California Institute of Technology, Pasadena, Calif. 49—APM-10

The Effect of an Axial Force on the Vibration of Hinged Bars With Fixed Ends, by S. Woinowsky-Krieger, professor, University of Pennsylvania, Philadelphia, Pa. (By title) 49—APM-2

On Vibrations of a Two-Bar Elastic System With a Small Rise, by S. Woinowsky-Krieger, professor, University of Pennsylvania, Philadelphia, Pa. (By title) 49—APM-1

12:00 noon

Luncheon

Michigan Union Cafeteria

2:00 p.m.

Session II

Impact of a Mass on a Column, by W. H. Hoppman, 2nd, assistant professor of mechanical engineering, Johns Hopkins University, Baltimore, Md. 49—APM-9

Graphical, Mechanical, and Electrical Aids for Compressible Fluid Flow, by H. Poritsky, B. Sells, and C. E. Danforth, General Electric Company, Schenectady, N. Y.

The Use of an Optical Property of Glycerine-Water Solutions to Study Viscous-Fluid Flow Problems, by W. W. Hagerty, assistant professor of engineering mechanics, University of Michigan, Ann Arbor, Mich. 49—APM-21

Introduction to the Comprex, by F. W. Barry, research assistant, Gas Turbine Laboratory, Massachusetts Institute of Technology, Cambridge, Mass. 49—APM-18

Holzer Method for Forced Damped Torsional Vibrations, by T. W. Spaetgens, stress and vibration analyst, Vivian Diesels and Munitions, Ltd., Vancouver, Can. (By title) 49—APM-12

6:30 p.m.

Informal Banquet

Toastmaster: Martin Goland, chairman, Applied Mechanics Division
Speaker: J. A. Perkins, assistant provost, University of Michigan, Ann Arbor, Mich.
Subject: The Underpinning of Education

TUESDAY, JUNE 14

9:00 a.m.

Session III

Discontinuities of Stress in Plane Plastic Flow, by Alice Winzer, research assistant, graduate division of applied mathematics, and G. F. Carrier, professor of engineering science, Brown University, Providence, R. I. 49—APM-8

The Relation of Experiments to Mathematical Theories of Plasticity, by D. C. Drucker, associate professor of engineering, Brown University, Providence, R. I. 49—APM-5

On Torsion of Plastic Bars, by P. G. Hodge, Jr., research associate, graduate division of applied mathematics, Brown University, Providence, R. I. 49—APM-3

The Influence of the Dimensional Factors on the Mode of Yielding and Fracture in Medium-Carbon Steel, by J. Miklowitz, research engineer, Westinghouse Research Laboratories, East Pittsburgh, Pa. 49—APM-20

A Comparative Study of Some Variational Principles in the Theory of Plasticity, by R. Hill, British Iron and Steel Research Association, Cavendish Laboratory, Cambridge, England. (By title) 49—APM-16

12:00 noon

Luncheon

Michigan Union Cafeteria

2:00 p.m.

Session IV

Biaxial Tension-Tension Fatigue Strengths of Metals, by J. Marin, professor of engineering mechanics, The Pennsylvania State College, State College, Pa. 49—APM-7

On Plastic Flow and Vibrations, by C. J. Thorne, associate professor of mathematics, University of Utah, Salt Lake City, Utah. 49—APM-23

A Matrix Method of Calculating Propeller-Blade Moments and Deflections, by R. Plunkett, assistant professor of mechanical engineering, Rice Institute, Houston, Texas. 49—APM-11

Stress Studies on Piping-Expansion Bellows, by F. J. Feely, Jr., group head, and W. M. Goryl, engineer, mechanical-engineering branch, Esso Engineering Department, Standard Oil Development Company, Elizabeth, N. J. 49—APM-22

Analysis of a Single Stiffener on an Infinite Sheet, by S. U. Benscoter, aeronautical research scientist, NACA, Langley Field, Va. (By title) 49—APM-13

7:00 p.m.

Lawn Party

Time and place of the lawn party will be announced at time of registration

WEDNESDAY, JUNE 15

9:00 a.m.

Session V

Joint Meeting With Committee on Applied Mathematics of the American Mathematical Society.

Deflections and Moments Due to a Concentrated Load on a Cantilever Plate of Infinite Length, by T. J. Jaramillo, research mathematician, Armour Research Foundation, Chicago, Ill. To be presented by Professor E. Sternberg. 49—APM-15

Determination of the Buckling Load for Columns of Variable Stiffness, by C. C. Miesse, research engineer, Battelle Memorial Institute, Columbus, Ohio. 49—APM-4

Effect of Imperfections on Buckling of Thin Cylinders and Columns Under Axial Compression, by L. H. Donnell, research professor, Illinois Institute of Technology, Chicago, Ill., and C. C. Wan, senior project engineer, Chance Vought Aircraft Company, Stratford, Conn. 49—APM-14

A Force Applied in the Median Plane at the

Center of a Circular Disk in a Plate, by S. Dokos, research engineer, Armour Research Foundation, Chicago, Ill. (By title) 49—APM-19

11:15 a.m.

Plastic Straining in Systems of Plane Strain and of Plane Stress, by Sir Richard Southwell, Fellow, Royal Society; formerly, rector of the Imperial College of Science and Technology, London, England.

12:30 p.m.

Luncheon

Michigan Union Cafeteria

2:00 p.m.

Session VI

Stress Analysis in Elastic-Plastic Structures by W. Prager, chairman, graduate division on applied mathematics, and P. S. Symonds, assistant professor of engineering, Brown University, Providence, R. I.

Kirchoff's Boundary Condition and the Edge Effect for Elastic Plates, by K. O. Friedrichs, professor of mathematics, New York University, New York, N. Y.

Beams Under Concentrated Loading, by G. E. Hay, associate professor of mathematics, University of Michigan, Ann Arbor, Mich.

1948 ASME Transactions Available

THE 1948 Transactions of The American Society of Mechanical Engineers, which includes the *Journal of Applied Mechanics*, a virtual depository of mechanical-engineering progress, profitable ideas, and information on specific problems, has recently been issued.

The well-indexed volume contains 1380 pages of opinions and achievements of 238 experts in 18 different phases of mechanical engineering. There are 151 technical papers, and discussions by 162 other engineers. To help users of the volume to visualize the significance of new developments in machinery, equipment performance, improved methods, and materials, 362 half-tone illustrations, 452 line drawings, and over a thousand data charts and schematic sketches are included. Carefully prepared bibliographies direct users to other sources for further information.

The volume is bound in dark blue buckram, with title stamped in gold. Price to members is $7.50, and to nonmembers, $15. Copies may be obtained from ASME Publication-Sales Department, 29 West 39th Street, New York 18, N. Y.

ASME Calendar

of Coming Events

May 2–4
ASME Spring Meeting, Mohican Hotel, New London, Conn.

June 13–15
ASME Applied Mechanics Division Conference, H. A. Rackham School of Graduate Studies, University of Michigan, Ann Arbor, Mich.
(*Final date for submitting papers was Feb. 1, 1949*)

June 27–30
ASME Semi-Annual Meeting, University of California Extension Building, San Francisco, Calif.
(*Final date for submitting papers was Feb. 1, 1949*)

Sept. 12–16
ASME Industrial Instruments and Regulators Division Conference and Exhibit, Municipal Auditorium, St. Louis, Mo.
(*Final date for submitting papers—May 1, 1949*)

Sept. 27
ASME Wood Industries Division Conference, Jamestown, N. Y.
(*Final date for submitting papers—May 1, 1949*)

Sept. 28–30
ASME Fall Meeting, Erie, Pa.
(*Final date for submitting papers—May 1, 1949*)

Oct. 2–5
ASME Petroleum Division Conference, Oklahoma Biltmore Hotel, Oklahoma City, Okla.
(*Final date for submitting papers—June 1, 1949*)

Oct. 26–27
ASME Fuels Division Conference, French Lick Springs Hotel, French Lick Springs, Ind.
(*Final date for submitting papers—June 1, 1949*)

Nov. 27–Dec. 2
ASME Annual Meeting, Hotel Statler, New York, N. Y.
(*Final date for submitting papers—Aug. 1, 1949*)

(*For Meetings of Other Societies see page 442*)

Erie Section Prepares for ASME 1949 Fall Meeting

THE American Society of Mechanical Engineers has accepted the invitation of the Erie Section to hold its 1949 Fall Meeting at Erie, Pa., Sept. 28–30, 1949.

Plans are well under way for a broad technical program to match the industrial diversity of Pennsylvania's fourth largest city.

Erie has a special interest for the mechanical engineer because of the surprising number of its industrial plants and the variety of its products. Actually there are more than 250 plants in the city producing over 600 different products ranging from excavating machines to paper products.

A few of the major industries follow:

The Erie General Electric Plant, which produces electric and Diesel electric locomotives, and the famous GE refrigerator. The plant employs over 15,000 persons.

The Erie Foundry Company, whose forging hammers are used in every part of the world where heavy forgings are required.

The Bucyrus-Erie Company, called the "world's greatest builder of excavating machinery."

The Hays Manufacturing Company, founded in 1869, and now nationally known as makers of high-grade brass fittings.

The Burke Electric Company, one of the oldest manufacturers of motors, generators, and special electrical devices.

The Northern Equipment Company, whose Copes feedwater regulators are well known throughout the world.

The Sims Company, producer of heaters, separators, and heat exchangers.

The Skinner Engine Company, founded in 1875, one of the largest builders of stationary and marine uniflow engines.

The Standard Stoker Company, builders of stokers for steam locomotives.

The American Sterilizer Company, producer of medical sterilizers and disinfectants.

The Reed Manufacturing Company, whose vises and pipe tools are used all over the world.

The Jarecki Manufacturing Company, whose production of valves, fixtures, oil-well supplies, and pipe-cutting machines makes them one of the three largest companies in this line of business in the United States.

The Metric Metal Company, which developed the orifice meter, is one of the largest manufacturers of meters for domestic and high-pressure users.

The Erie Forge Company, noted for precision in machining forgings and high-quality steel castings.

The Lovell Manufacturing Company, well-known as manufacturers of wringers.

Louis Marx and Company, famous for its toys the world over.

Other nationally known products are: the cooking utensils of the Griswold Manufacturing Company; the gas ranges of the Odin Stove Manufacturing Company; the rubber products of the Continental Rubber Works; and the bond paper of the Hammermill Paper Company.

Production in Erie continually changes as the years pass. The history of the area can be followed in the list of "vanished industries" of Erie. It includes coal stoves, wooden wheels, parlor organs, wagons, carriages, sleighs, candles, "Tribune bicycles," horseshoes, and many other products that have vanished for social or economic reasons.

Since a concentration of industry usually means a concentration of engineers, ASME hosts at the Fall Meeting can be counted upon to provide a program of inspection trips and social events rich in opportunity for pleasure and profit. Local arrangements are already well under way.

ASME Junior Forum

Compiled and Edited by a Committee of Junior Members, B. H. Edelstein, Chairman

Junior Committee to Explore New Services for Young Engineers

HELPING the young engineer to grow professionally was one of the topics discussed by the National Junior Committee at an all-day meeting held at Society headquarters, New York, N. Y., April 2, 1949.

Present were: D. E. Jahncke, chairman, from the Detroit Section; F. Everett Reed, Boston Section; John B. Burkhardt, Chicago Section; C. H. Carman, Jr., Metropolitan Section; H. D. Moll and S. P. Higgins, Jr., Philadelphia Section; B. H. Edelstein, chairman, Forum Editorial Committee, George B. Thom, adviser; A. F. Bochenek, staff, and C. E. Davies, secretary, ASME.

The suggestion that the Junior Committee undertake the task of evaluating the services which the Society provides for young engineers with a view of proposing improvements, was made by C. E. Davies and set the discussion off. This job was logically one for junior members, he said, because junior members, working under various conditions of employment, are acutely aware of services that may help them. The ASME is conscious of its responsibility for creating opportunities for the professional development of its younger members, and is especially concerned about juniors who find themselves in large groups doing about the same kind of work or in situations which make them likely prospects for union membership.

The best way to find out what juniors want from the Society is to ask them. It was agreed, therefore, to invite about ten juniors working under managements who are known to have differing policies with regard to engineering training, to meet with the Committee at its next meeting for an informal conference on several selected topics. These exploratory discussions, it is hoped, will bring out ideas which may help to strengthen the Society's program for its young members.

The Forum

Another perennial problem to which the Committee has been giving much attention is the Junior Forum and how it should be used to meet the needs of juniors. The Forum was originally created to give an outlet for the gripes, but during the past two years it has become increasingly evident that any dissatisfactions that may exist among junior members, indeed if they exist at all, are so minor in nature that juniors do not feel compelled to write about them. There still remains for the Forum the tasks of reporting the activities of the National Junior Committee, stimulating junior activity in the Society, and of expressing junior opinions on questions before the Society.

If these tasks are to be carried out properly, editorial direction of the Forum must have the aid of juniors residing in regions other than Region II which consists wholly of the Metropolitan Section. Mr. Edelstein pointed out that a great deal of time has been devoted to correspondence with selected junior members in an effort to enlist their co-operation in the Forum. Little success has accompanied this effort. Juniors generally seem to overlook the Forum as a means of giving national publicity to their brain children.

Annual Meeting

At its February 5th meeting the Committee agreed to sponsor a program at the 1949 Annual Meeting in New York. Mr. Carman reported that he had written to the Meetings Committee requesting time after the Students and Members Luncheon for the Committee's program. Various topics for the session were discussed, the consensus being that some general subject relating to the Society and the engineering profession on the theme of self-help would be appropriate. Mr. Jahncke agreed to talk about the work of the Junior Committee. Several speakers were suggested to develop the proposed theme.

Student Members

The Committee also reviewed progress on a folder which is currently being prepared for distribution to engineering students. This will be similar in treatment to the folder, "It's Up to You," which was prepared last year and distributed among junior members. The folder will present information about the ASME and will list the benefits of student-branch membership. A second folder, one for the engineering student who is about to graduate but who has not yet made up his mind about transferring to the junior grade, is also planned.

What's in a Name?

The ECPD is currently working to establish uniform membership grades among the major engineering societies. The Committee expressed itself in favor of ASME adoption of the ECPD membership grades. Such action will mean that "Junior Member" will be abolished and "Associate Member" substituted for it. The name junior was reported as distasteful to young engineers who feel that "junior" is a derogatory connotation, and that some young engineers feel so strongly about being called a junior that they refuse to join an organization which classifies them as adolescents.

Good Insurance

To insure success pick the right boss and proceed to make his life easy.[1]

Junior Advisers

Junior members are currently serving in an advisory capacity on five administrative committees of the Society. Because it is desirable for juniors appointed for this service to attend regular meetings of these committees, it has been necessary to appoint only members who reside in the New York Metropolitan area. The Junior Committee has had under consideration for some time a plan to increase the number of committees having junior representation, and to find some way of financing travel to committee meetings for juniors from other Regions. Mr. Burkhardt reported on his review of Society committee structure and concluded that there are four other committees which might welcome junior representation. These were, he said, the Admissions, Membership Development, Membership Review, and the Education Committees. As a source of financial support for juniors residing away from New York, Mr. Carman called attention to the offer made by the Old Guard Committee at the 1948 Annual Meeting. According to F. D. Herbert of the Old Guard Committee, his group has funds which it is seeking to invest in worthy projects. Mr. Carman agreed to discuss the junior-adviser problem informally with Mr. Herbert.

Philadelphia Junior Group Aids Local Student Branches

IN order to establish a close relationship between the Philadelphia Junior Group and the student branches from the nearby colleges, a joint Junior-Student Committee meeting was held at the Philadelphia Engineers Club, Feb. 19, 1949. Present at the meeting were: William McLaughlin and Stephen P. Higgins, Jr., Philadelphia Junior Group; Harry E. Mankonen, Drexel Institute of Technology; James R. Anderson, Serge Gratch, and A. H. Holcombe, University of Pennsylvania; Michael S. Saboe and James J. Boyle, Villanova College; William E. Reaser and James S. Hayes, Swarthmore College.

Membership lists were requested from the student chairmen in order that a student directory could be compiled by the Student-Relations Committee. A system was set up for meeting notices in order to enable the juniors to have representatives present at the student meetings.

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[1] New Proverbs for Young Engineers, by Philip W. Swain, editor, *Power*, McGraw-Hill Publishing Company, Inc., New York, N. Y. Mem. ASME.

Methods were discussed for increasing participation of student graduates in the Junior Group, and it was agreed that if student members were well acquainted with Junior Group activities prior to graduation, they would be more likely to become active junior members.

The Student-Relations Committee offered to aid the student branches with their program problems, and it was suggested that a list of good industrial films would be helpful to the student chairmen.

Considerable interest was shown in the subject of jobs for students, both before and after graduation. In answer to the problem of profitable summer work, the Swarthmore representatives explained their approach to the problem. Questionnaires were sent out to alumni inquiring about summer job opportunities, and the number returned enabled them to place students in summer jobs which met their needs. It was decided that there would be interest in a discussion by a junior of his particular type of work, the discussion to be given at a student-branch meeting.

The need for papers of a technical and nontechnical nature by students was stressed. It was suggested that the publication of the student papers presented at the Regional competition would be a worth-while project. A Philadelphia student-paper competition was also suggested, possibly as a preliminary to the Regional competition.

The meeting was concluded with a feeling that a spirit of co-operation had been established and that many projects had been suggested to make possible an active junior-student program.

Chicago Juniors Discuss Civic Responsibility

THE Junior Group of the ASME Chicago Section held a meeting on March 22, 1949, at which W. A. Dundas, Mem. ASME, and general superintendent of the Sanitary District of Chicago, spoke on the engineer's place in politics. Mr. Dundas, who is chairman of the Civic Responsibility Committee of the Chicago Section, urged engineers not to lose sight of civic duties in their concentration on engineering proficiency.

Because of the increasingly complicated problems of government and human affairs, he said, it is imperative that engineers extend their education beyond the specific interest of the professional sciences into the field of citizenship.

"All too often our knowledge of government, civic affairs, and politics is gained from the daily press. Unfortunately, much of this material is conflicting and biased, resulting ultimately in confusion.

"Many of the local groups of our engineering societies have contributed enormously in a professional way to their communities. Probably two of the most outstanding groups in this activity are The Western Society of Engineers in Chicago, and the Engineering Society of Detroit.

"This service, however, should be expanded beyond a technical basis. Greater effort should be made to place more engineers in policy-forming offices of government, both local and federal."

Engineers Responsible for Social Problems

Since engineers are responsible for many of the social and governmental problems which are the result of technological achievement, it was unfair, Mr. Dundas said, to lay these problems on the doorstep of others. Only when engineers have learned to master their civic duties as well as their professional ones, will the engineering profession truly achieve greatness.

"Recently I had occasion to discuss some legislation relative to a certain public-works project with an elected official," he continued. "In the course of the discussion I made reference to a report prepared by a capable engineer. This reference brought forth a statement to the effect that the man was a capable engineer and as such he should leave all matters of legislation to the politicians and lawyers. What does he know about matters of legislation? This hired-help attitude toward engineers is quite common, particularly in government, and I ask you frankly, should we be proud of it and do we wish to perpetuate it?

"It would be wrong to assume that we are all capable of holding and discharging the duties of public office efficiently. Such an assumption would be fantastic. The simplest citizenship duty which one can perform is the intelligent use of the ballot. This basic duty, like that of jury service, has been neglected by many for the inexcusable reason that they were too busy to take time to vote or could not afford to spend several days sitting in a courtroom listening to someone's troubles.

"In order to exercise the ballot efficiently, it is necessary to know about politics, governmental organization, its functioning, and the qualifications required for the incumbents to function efficiently in their respective public offices.

"Personalities and politics have a great bearing in the conduct of civic and governmental affairs; therefore it is obvious that one should learn as much as possible about the political leaders in his community."

One way this can be done, Mr. Dundas said, was for engineering organizations to invite public officials and candidates for public office to talk at their meetings. In this way, firsthand knowledge of policies and capabilities of public officials can be obtained.

Politics Not a Dirty Game

"Many people are of the opinion that politics is a dirty game and that politicians are dishonest. Generally speaking, I believe this is not a true impression. I believe that the great majority of public officials elected from the general cross section of our citizenry are anxious to do a good job. They are called upon to handle problems of the broadest conceivable range, but through lack of proper knowledge and experience are often unable to do so. Public officials of this type should receive our help and guidance unsparingly. If our politics are dirty and public officials are dishonest, it is our duty to correct these things and put our house in order."

Mr. Dundas noted that the managements of some large industries frowned on participation of its officials in civic affairs and politics. This was a shortsighted policy, he said, which prevented many capable leaders from entering a field of service in which they are badly needed.

To be citizens first, it was not necessary for engineers to desert their professional interests, Mr. Dundas concluded. "We must advance beyond the gates of our cloistered realms of science, face facts, and perform the duties of citizenship to the fullest extent of our abilities."

Professional Recognition for Young Engineers

IN the February issue of the magazine, *Nation's Business*, there appeared a report of a speech by James M. Todd, president ASME, discussing the professional status of the younger engineer. In the article Mr. Todd indicates that in our industrial establishments the young lawyer or doctor is placed on the same plane with the administrational and organizational heads, but the young engineer is expected to have a number of years of experience before attaining such a position. Mr. Todd then suggests that the technical societies should give fuller recognition to the professional status of the younger engineer.

In response to this article Mr. Todd received the following letter:

Dear Mr. Todd:

While en route to West Virginia by train, I picked up a copy of the February issue of *Nation's Business* in the parlor car. This particular issue contained a report of your recent speech to the members of The American Society of Mechanical Engineers during your Society's Annual Meeting.

The main point of your speech described the way young engineers just out of school are always labeled "junior" and not put on a par with other professional men such as doctors, dentists, and lawyers.

May I strongly and heartily give you a mannerly bit of applause. Because of this particular reason, a great many potentially good young technical graduates have divorced themselves from their trained fields.

Let me relate my own particular case. Because of financial difficulties, I left school to return to work. I was educated in a technical high school and had four years of drafting and three years of machine shop.

In less than two years, I rose from a detail draftsman to special assistant to the chief engineer of a large corporation. It was my job to design special machines and make quick sketches of smaller equipment for the much older designers to finish.

My superiors kept after me to quit and return to college. I did just that after almost five years and three patents later. At school, I swallowed my pride to listen to nonexperienced men tell me about design and industry. I even found time to spend twenty hours a week designing special drilling machinery and multiple-spindle drill heads.

Then came graduation and a flood of personnel managers from Maine to California to paw and blow about their future rainbows.

One firm, a large camera manufacturer, offered me a position as a junior designer with a future at $203 per month.

Another corporation, the world's largest machine-tool factory, paid my expenses to their factory. I was treated like a potential king for two days, trips through the factory, handshaking, inflated future, and then even a meeting with all the executives to discuss my future.

They were offering me the opportunity to spend two years learning how to run machine tools and design tools in their school at 88 cents an hour. I was actually an apprentice; in two years I would be a junior engineer.

I came home, prepared a sales letter and went into the technical-sales field. I felt that being a "junior" was perfectly wonderful as long as I was a junior in the field.

This letter can go on indefinitely and I can list a great many engineers in our own organization that have taken a similar stand.

Bravo, Mr. Todd, don't sit still on this program. It is men like yourself that can put the engineer back in the professional field at a status where they belong.

GENE R. WALPER.[2]

Importance of Orientation

Mr. Walper presents an interesting case for a number of our fellow engineers who had broad experience before attending college, and it is obvious that a number of the excellent training programs, corresponding somewhat to a doctor's internship, offered by industrial concerns, do not apply to his case. Probably if he had embarked on the apprentice course his employers would have found out that he was a special case which did not fit, and would have transferred him to a more suitable position. However, the engineer's training course is more than an apprentice course; it is a course in orientation during which the engineer gets to know the other men in the organization and to recognize that he is a member of a team. No man, however great his abilities, can contribute his fullest to his employer until he knows the organization and people he must work with.

In the U. S. Civil Service men are regularly rated on their fulfillment of the requirements of their position, and it is expected that no man should be rated "excellent" until he has held a position for over a year. I have talked with engineers who were graduated from college and, bubbling with enthusiasm over their knowledge, have taken positions with some company which does not give emphasis to the theoretical aspects of their problems. The sad thing is that after a year when on the basis of quiet competence and excellent work they are on the threshold of carrying their points, their discouragement becomes too great and they resign to seek another position.

The engineer is a cautious creature even when he is your employer, and so has to be shown. Showing usually takes time.

Professional recognition is a subject on which other members may have opinions. If so, these should be put in writing and sent to the Forum.

F. EVERETT REED, JR.[3]

Pittsburgh Junior Meeting

"THE Junior Engineers' Problems in Industry" was the subject of a meeting held for Junior and Student members in Mellon Institute Auditorium on March 29, 1949. The meeting was conducted after the manner of a town-hall meeting with a moderator and panel of experts chosen from the fields of research, design manufacturing, and sales. Following short introductory remarks by each of the experts representating experience and authority in their chosen fields, H. N. Muller, Jr., manager, educational department, Westinghouse Electric Corporation, Pittsburgh, Pa., who acted as moderator, called for questions from the audience, and directed them to the appropriate member of the panel for answering.

Members of the panel of experts were: Research, E. W. Jacobson, design engineer, Gulf Research and Development Company, Pittsburgh, Pa.; design, E. E. Hedene, chief engineer, Nordstrom Valve Division, Rockwell Manufacturing Company, Pittsburgh, Pa.; manufacturing, J. T. Ryan, Jr., general manager, Mine Safety Appliances Corporation, Pittsburgh, Pa.; and sales, R. S. Kersh, industrial sales manager, Westinghouse Electric Corporation, Pittsburgh, Pa.

Career Opportunities

ELECTRIC utilities are engineering enterprises which offer good opportunities for engineering careers, according to Frank E. Sanford, director of research and development, Copper Wire Engineering Association, Chicago, Ill., whose article, "Career Opportunities in the Utility Field," appeared in the January issue of *Electrical Engineering*. Although Mr. Sanford points his remarks to electrical engineers, what he says makes interesting reading to mechanical engineers, large numbers of whom have found careers in the electric-power field.

Mr. Sanford states that three quarters of the men at management level started in the technical divisions, and of the 25 largest utility systems in the United States, 12 are guided by presidents who started as engineers. The trend seems to be in the direction of engineering management because six of the men who have taken that office in recent years were engineers.

Larger Staffs Foreseen

Three factors in the electric utilities combine to create exceptional opportunities for young men who will enter the field in the next few years. These are:

1 The electric utilities must employ three times the number of young engineers in the next 15 years that they have employed in the past 15 years if they are to maintain their present engineering personnel.

2 Between now and 1960, there must be added to the engineering staffs 50 men for every 100 now employed.

3 The rapid growth of the engineering group in the decade 1920–1930, with a drop in the rate during the following decade and a virtual standstill in employment during the war period, will be reflected in the future rate of retirement.

Mr. Sanford estimates that by 1960 one half of all the present engineering positions must be filled by students or young graduates of today with 10 years or less of experience. By 1970 all but 20 per cent of the engineering personnel will be made up of the younger group. Five years later, when most of the young men of today will be still in their forties, they will take over about all of the responsibility in the field.

In addition to opportunity, electric utilities offer traditional stability and employment security. Electric power—generation, distribution, and application—has had a continuous growth, both in capacity to serve and in energy sales. The rate of increase has varied some, but the fact of an increase in every year is notable through the period spanning two wars. There is every indication that the industry will continue that record with no letdown in the predictable future.

Future Growth of Industry

One long-range projection, considered to be conservative, is on the premise that the rate of growth in the next 30 years may be only one half of the past 30 years. That would require engineering plans for an industry five times as large as at present. Plans to meet power requirements on the basis of a 50 per cent increase in five years or of 75 per cent increase in ten years, are in the shorter-range predictions.

Stability, as it is applied to the electric-utility experience, describes a condition of continuous growth rather than the mere absence of severe ups and downs. It is the continued need to solve engineering problems and to plan new construction that makes the utility type of stability so favorable for the engineers. The plant is never finished to settle into a routine operation.

There will be one more issue of the Junior Forum before the summer season slows down Section and Junior Group Activities. The June Forum will be the last until the October issue.

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[2] Fairbanks, Morse and Company, Chicago, Ill.

[3] Mem. ASME National Junior Committee, assistant professor, mechanical engineering department, Massachusetts Institute of Technology, Cambridge, Mass.

Activities of the ASME Executive Committee

At a Meeting at Headquarters, March 24, 1949

A MEETING of the Executive Committee of the Council was held in the rooms of the Society on March 24, 1949. There were present: James M. Todd, chairman, T. E. Purcell, vice-chairman, F. S. Blackall, Jr., E. J. Kates, Forrest Nagler, of the Executive Committee; J. H. Lawrence (Finance), K. H. Condit (Organization), K. W. Jappe, treasurer, C. E. Davies, secretary, and Ernest Hartford, executive assistant secretary.

Publications Plan

The Committee noted that the publications plan put into effect since January, 1948, is under review by the Publications Committee and that a report commenting on criticisms and suggestions received from members will be submitted soon.

Consultative Body to ECPD

Upon recommendation of the Board on Education and Professional Status, sponsorship by the ASME of a consultative body to the ECPD was authorized. The proposed body is to provide for meetings at which various societies in the mechanical-engineering field can discuss common problems on engineering education and other professional matters. It was agreed to invite the following societies to appoint representatives to the proposed body: American Society of Heating and Ventilating Engineers, Society of Automotive Engineers, American Society of Refrigerating Engineers, American Society of Agricultural Engineers, The Institute of Aeronautical Sciences, American Society of Tool Engineers, and the Instrument Society of America.

Roy V. Wright Lectureship

As a memorial to the late Roy V. Wright, past-president and honorary member ASME, it was voted to authorize establishment of a Roy V. Wright Lectureship and to request the Engineers' Civic Responsibility Committee to set up necessary rules for administration.

Sections

Upon recommendation of J. Calvin Brown, vice-president, ASME Region VII, establishment of an Arizona Section was authorized.

Upon request of the Tri-Cities Section and with the approval of Forrest Nagler, vice-president, ASME Region VI, the name of the Tri-Cities Section was changed to the Iowa-Illinois Section.

Survey of Engineering Personnel

In support of a project of the Office of Naval Research whose objective is a roster of engineers qualified in the field of engineering research and development, the secretary was authorized to negotiate a contract with the ONR establishing the ASME as contracting agency for the Engineers Joint Council. The contract will provide for EJC co-operation in the project.

Certificates of Award

Certificates of Award for the following Section chairmen were approved: Thomas A. Fearnside, Boston; Richard E. McClain, Central Illinois; and James K. Ludwickson, Nebraska.

EJC Constitution

The revised constitution of the Engineers Joint Council was approved.

EIC-ASME Joint Conference Committee

In accordance with action of the Ontario Section requesting that its chairman be invited to meetings of the Joint Conference Committee of the Engineering Institute of Canada and The American Society of Mechanical Engineers, the president was authorized to appoint C. G. Southmayd as the Ontario Section representative on the ASME delegation attending the Quebec meeting of the EIC-ASME Joint Conference Committee. The Ontario Section will also be represented at the meeting planned for November, 1949. A recommendation to the Organization Committee that representatives of the Ontario Section be considered in future appointments to the Joint Conference Committee was also approved.

Welding Research Council

Upon recommendation of the ASME Boiler Code Committee, a contribution was made to the research fund of the Welding Research Council.

Appointments

The following appointments were approved:

Frank M. Gunby, as ASME representative to the M.I.T. Mid-Century Convocation on the Social Implications of Scientific Progress, and to the inauguration of James R. Killian as president.

Arthur Roberts, Jr., as ASME representative to the inauguration of Walter S. Newman as president of Virginia Polytechnic Institute.

1949 Society Records Sent Upon Request

MEMBERS of The American Society of Mechanical Engineers who wish to receive copies of the February, 1949, issue of Society Records containing council and committee personnel, or the April, 1949, issue containing memorial biographies, are requested to write to the Secretary, ASME, 29 West 39th Street, New York 18, N. Y. In accordance with the new policy recently adopted by the Council, the April, 1949, issue of Society Records will be the last to contain memorial biographies.

Section Activities

REPORTS of the following ASME Section Meetings were received recently at Headquarters:

Baltimore, Feb. 28. Speaker: Dr. D. W. Bronk. Subject: Greater Co-operation Between the Engineering and Medical Professions. Attendance: 240.

Boston, March 21. Speaker: J. M. Todd, president, ASME, and F. S. Blackall, Jr., director at large, ASME. Subjects: Economics and ASME. Economic Aspects of a Progressive and Prosperous Business. Attendance: 142.

Central Indiana, March 18. Speaker: R. L. Lerch. Subject: Development and Uses of Corrosion and High-Temperature Alloys. Attendance: 90.

Cincinnati, March 3. Annual Student Branch Night. Students from nearby colleges were guests of the Section. Attendance: 166.

Cleveland, March 10. Speaker: W. J. King. Subject: Personal and Professional Problems of Engineers. Attendance: 98.

Colorado, Feb. 11. Speaker: Col. T. P. Sears. Subject: Basic Physics and Hazards of the Atomic Bomb. Attendance: 22.

March 11. Speakers: R. F. Throne and A. A. Woodward. Subject: New Steam Development at Lacombe Station, Denver, Colo. Attendance: 67.

Dayton, Feb. 23. Speaker: H. Deardorff. Subject: Planning and Construction of the new O. H. Hutchings Station. Attendance: 150.

March 8. Speaker: H. H. Storch. Subject: Synthetic-Liquid-Fuel Processes. Attendance: 175.

Detroit, March 9. Joint meeting with the Twenty-Seventh Fuel Engineering Conference. Address of welcome: Hon. E. Van Antwerp, mayor of the City of Detroit. At dinner following the meeting, the speaker was W. S. Cisler. Subject: Expansion in the Electric-Utility Industry. Attendance: Over 900.

East Tennessee (Oak Ridge Sub-Section), March 23. Speaker: J. H. Rushton. Subject: Technology of Mixing. Attendance: 35.

Milwaukee, March 9. Speaker: G. K. Viall. Subject: The Development Engineer and His Place in Industry. Inspection trip to plant of Chain Belt Co. Attendance: 100 on inspection trip; 240 at meeting.

New Orleans, March 25. Speaker: Col. E. S. Lawrence. Subject: Mississippi River. Attendance: 54.

North Texas, March 1. Inspection of Handley Plant of the Texas Electric Service Co. Speaker: C. W. Geue. Attendance: 107.

March 28. Speaker: O. de Lorenzi. Subject: Methods for Burning Liquid and Gaseous Fuels. Attendance: 92.

Philadelphia, March 22. Speaker: O. de Lorenzi. Subject: Methods of Firing Pulverized Coal and Methods for Burning Liquid and Gaseous Fuels. Attendance: 198.

Rock River Valley, March 24. Speakers: C. T. O'Harrow and H. G. Bolton. Subject: Carburetion Engineering. Attendance: 54.

San Francisco, Feb. 24. Speaker: D. T. Morganthaler. Subject: Feedwater Regulation. Attendance: 100.

Savannah, March 16. Speaker: A. E. Creek. Subject: Jet Propulsion. Attendance: 45.

Schenectady, March 17. Speaker: J. B. Klopp. Subject: The New Turbine Plant. Attendance: 40.

South Texas, Feb. 24. Speaker: E. A. Koenig. Subject: Gas-Transmission Compressor-Station Design and Operation. Attendance: 80.

March 17. Junior Group. Speaker: P. Darling. Subject: Petroleum Refining From a Mechanical-Engineering Standpoint. Attendance: 67.

Susquehanna, March 14. Speaker: A. G. Christie. Subject: Industrial Research. Attendance: 25.

Western Washington, Feb. 23. Joint meeting with student branch, University of Washington. Attendance: 57.

Youngstown, March 10. Inspection trip through plant of the Deming Co., Salem, Ohio. Attendance: 50.

Student Branch Activities

REPORTS of the following ASME student branch meetings were received recently at Headquarters:

Alabama Polytechnic Institute, Feb. 21. Film: Operations Crossroad. Attendance: 55.

March 7. Two films on technical subjects shown. Attendance: 30.

March 28. Paper by student G. Hamer. Attendance: 48.

University of Arkansas, March 2. Business meeting. Attendance: 30.

March 11. Eighteen members of the branch attended the annual meeting of the Mid-Continent Section in Tulsa, Okla. Papers were presented by students, the first prize going to Louis E. Sanders, senior from Cullendale, for his paper: Revolution in the Foundry. Inspection trip through the plant of the Liberty Glass Co., Sapulpa; the Commander Mills, Sand Springs; and the Garden City Plant of Public Service Co.

University of California, Feb. 28. Speaker: J. C. Brown, vice-president, ASME Region VII. Subject: Perpetual-Motion Machines. Attendance: 135.

Case Institute of Technology, Feb. 22. Two films: Bridging San Francisco Bay, on bridge building; and Crystal Clear, describing production of crystals used in telephone communications. Attendance: 55.

March 10. Joint meeting with the Cleveland Section. Speaker: J. L. King. Subject: Personal and Professional Problems of the Engineer. Attendance: 96.

March 22. Speaker: H. B. Osborn. Subject: What's New in Industry. Attendance: 30.

Clemson College, March 8. Speakers: R. W. Way, N. D. Wagner, and W. A. Gaines, Jr. Subjects: Steel Fabrication; Heat Radiation; and Educational Power Plant. Attendance: 78.

March 22. General business meeting. Attendance: 40.

University of Colorado, March 3. Speaker: R. C. Treseder. Subject: Propellers. Attendance: 100.

University of Connecticut, March 10. Joint meeting with the Engineers Club. Speaker: W. F. Ryan. Subject: Some Aspects of Professional Engineering in Respect to Registration and Licenses. Attendance: 97.

Drexel Institute, Jan. 26. Speaker: A. C. Fulton. Subject: Opportunities in Machine Design. Attendance: 52.

Feb. 9. Speaker: R. E. Lane. Subject: Model Tests of the Southwark Station Boilers and Results, illustrated with slides. Attendance: 39.

Duke University, March 16. Student paper presented by B. Clark. Subject: Preparation of Engineering Students for Citizenship. Attendance: 20.

George Washington University, March 2. Talks by three student members. Winner: Harry B. Crosswell, who received an engineering handbook of his choice as a prize. Attendance: 41.

University of Idaho, March 22. Program: Talks by two representatives of the Caterpillar Tractor Co. on some of the company's problems. Attendance: 63.

Illinois Institute of Technology, March 8. Speaker: J. T. Rettaliata. Subject: Jet Propulsion. Attendance: 200.

March 15. Speaker: L. Jacobsmeyer. Subject: Special Brazing and Annealing Processes. Attendance: 120.

March 17. Joint meeting with AIEE. Speaker: A. D. Bailey, past-president ASME. Subject: Our Place and Future as Engineers. Attendance: 400.

University of Illinois, Feb. 17. Election of officers for spring semester. Speaker: S. Dubin. Subject: What Other People Think of the Engineer. Attendance: 105.

Iowa State College, Feb. 23. Speaker: Prof. Hay. Subject: Styling and the Machine Designer. Attendance: 84.

March 2. Election of officers. Attendance: 50.

State University of Iowa, Feb. 9. Election of officers.

Feb. 23. Films: The 49th State; and Safeguarding the Speech Ways.

March 2. General business meeting.

March 9. Speaker: Prof. R. Buckwalter. Subject: The Behavior of Prestretched Structural-Steel Beams.

March 16. General business meeting.

March 23. Speaker: I. R. Gertz. Subject: Planning and Construction of 50-Ft Parabolic Mirror for U. S. Navy Department.

March 30. Two student papers by Norman Hunstad and Paul Chalupsky.

Kansas State College, March 10. Speaker: M. A. Edwards. Subject: The Speaker's Early Experiences in the Field With General Electric. Attendance: 138.

University of Kansas, Feb. 17. General business meeting. Attendance: 60.

University of Kentucky, Feb. 24. Musical program by Men's Glee Club.

March 10. Speaker: Mr. Friedly, a student representative of the World Student Service Fund. Subject: Benefits of the WSSF to foreign students.

March 24. Speaker: R. G. Lee. Subject: The Menace of Mediocrity.

Lafayette College, Feb. 24. Election of officers. Speaker: W. H. Jackson. Subject: Discussion and showing of film, Steam for Power. Attendance: 64.

Lehigh University, March 3. Joint meeting with AIEE. Speaker: C. T. Pearce. Subject: Opportunities for a Technically Trained Engineer in a Large Electrical-Manufacturing Organization. Attendance: 80.

Louisiana State University, Feb. 15. General business meeting. Attendance: 49.

Michigan College of Mining and Technology, Feb. 1. General business meeting.

Feb. 15. Program: Two films. Watts in Glass; and Gasoline's Amazing Molecules. Attendance: 15.

March 1. Speaker: Prof. Polkinghorne. Subject: Engineering Registration. Attendance: 25.

March 15. General business meeting. Attendance: 20.

Michigan State College, Feb. 9. Speaker: T. A. Boyd. Subject: Glimpse of Engineering in the Automotive Industry.

Feb. 23. Speaker: N. Kulick. Subject: The Heat Pump. Attendance: 72.

University of Michigan, March 2 and 3. Field trip to the Dix Road plant of the Nash-Kelvinator Corp. Attendance: 150.

March 16. General meeting. Attendance: 250.

March 29. Annual ASME banquet. Speaker: G. F. Rodewig. Subject: Planning an Engineering Career Without Setting a Goal. Attendance: 151.

University of Minnesota, Feb. 23. Election of officers. Film: Collapse of the Tacoma Narrows Bridge. Attendance: 90.

March 30. General business meeting. Attendance: 65.

Mississippi State College, March 3. Speaker: B. M. Davis. Subject: Meaning and Necessity of Sales Engineering. Film: Steam for Power. Attendance: 54.

University of Missouri, Feb. 28. General business meeting. Attendance: 74.

University of Nebraska, March 2. Speaker: A. Dowling. Subject: Problems and Difficulties Encountered in Improving Industry in an Agricultural State. Attendance: 73.

March 16. Program: Three student papers presented. Attendance: 61.

University of New Hampshire, Feb. 9. Speaker: C. Quimby. Subject: What Can Be Expected in the Machine-Tool Industry for Graduate Engineers.

March 9. Speaker: Prof. A. Welch. Subject: New Technology Building at University Experiment Station.

New Mexico State College of A and M Arts, March 4. Speaker: Mr. Pennington. Subject: Aluminum, Where, Why, and How. Film: Pigs and Progress, showing processing of aluminum from bauxite. Attendance: 40.

March 17. Talks by student members. Attendance: 25.

University of North Dakota, March 8. Field trip to Grand Forks REA Power Plant and inspection of Diesel-powered equipment. Attendance: 27.

March 22. Speaker: A. F. Lyster. Subject: Lubrication, Lubricating Fluids, Cutting Fluids, and Fuel Oils. Attendance: 80.

Northwestern University, March 8. Election of officers. Speaker: H. Henning. Subject: How I Make Precision Gage Blocks. Attendance: 21.

University of Notre Dame, Feb. 23. General business meeting. Attendance: 60.

Ohio State University, Feb. 24. Speaker: J. K. Hulbert. Subject: Aspects of New Wind-Tunnel Laboratory Under Construction at Don Scott Airfield for Ohio State University. Attendance: 32.

March 8. Joint meeting with Columbus Section ASME. Program: Student Speakers' Contest. Winner: Russell Annis. Attendance: 28.

Oklahoma A and M College, Feb. 14. Speaker: J. C. Holmberg. Subject: Stainless Steels. Attendance: 63.

Feb. 28. Speaker: Mr. Bigler. Attendance: 120.

University of Oklahoma, March 2. Speaker: D. M. Frey. Subject: Modern Motor Fuels. Attendance: 50.

March 22. Speaker: C. J. Eckhardt, vice-president, ASME Region VIII. Subject: Engineering Success in a Changing World. Attendance: 75.

Oregon State College, Jan. 12. Film: Tornado in a Box. Attendance: 70.

University of Pittsburgh, Feb. 17. Speaker: J. M. Ferguson. Subject: Economics in General. Attendance: 203.

March 3. Film: Bridging San Francisco Bay. Attendance: 198.

March 17. Speaker: H. W. Erving. Subject: Marriage. Attendance: 199.

Polytechnic Institute of Brooklyn, March 1. Speaker: Prof. M. Balicki. Subject: Educational Systems of European Nations. Attendance: 96.

Princeton University, March 9. Speaker: Dean K. Condit. Subject: Princeton Engineering School of Thirty-Five Years Ago. Attendance: 32.

March 11. Trip to General Motors Turnstedt Division plant, Trenton, N. J. Attendance: 17.

Rice Institute, March 7. Speaker: L. V. Uhrig. Subject: Measurement of Bottom-Hole Pressures and Temperatures in Oil Wells. Attendance: 29.

University of Rochester, March 24. Film: Bridging San Francisco Bay. Attendance: 17.

Rose Polytechnic Institute, Feb. 25. Speaker: F. L. Wilkinson. Subject: Place of the Engineer in Public Life. Attendance: 43.

University of South Carolina, March 9. Speaker: K. Leland. Subject: The Honor System in College. Attendance: 49.

March 23. Speaker: P. Palmer. Subject: The Shrimping Industry Along the Carolina Coast. Attendance: 55.

University of Southern California, March 25. Speaker: S. Q. Dugid. Subject: Foreign Engineering. Attendance: 64.

Southern Methodist University, March 1. Joint meeting with North Texas Section ASME, at New Handley Generating Station of Texas Electric Company. Speaker: G. W. Geue. Subject: Importance of Privately Owned and Operated Business in Our Democratic Form of Government. Attendance: 32.

Stanford University, March 1. Presentation of ASME award to Dr. William F. Durand in recognition of 65 years of faithful service to ASME. Speaker: J. C. Brown, vice-president, ASME Region VII. Subject: Perpetual-Motion Systems. Attendance: 27.

Stevens Institute of Technology. Speaker: R. C. Hitchcock. Subject: The Westinghouse March of Research Show. Attendance: 425.

Tufts College, Feb. 21. Speaker: Prof. A. Magoun. Subject: The Proper Approach to an Employment Interview.

March 16. Speaker: L. E. Newman. Subject: Machine Design as a Career.

March 22. Annual student papers' meeting. Six papers by four seniors and two juniors.

U. S. Naval Academy (Midshipman School), Feb. 9. Speaker: Comdr. Slayson. Subject: Aircraft Engines.

Feb. 13. Film: Boulder Dam.

Feb. 16. Film: Sand and Flame.

Feb. 22. Field trip to Air Test Center, Naval Air Station, Patuxent River, Md.

Feb. 23. Film: Steam Power for American Sea Power.

Virginia Polytechnic Institute, Feb. 15. Program: Showing of time slides on fluid drive and its applications, by R. L. Graham. Attendance: 226.

Feb. 22. Film: Prospecting for Petroleum.

March 1. Talk: Atomic Energy, So What, by N. O. Wagenschein, student. Film: Of This We Are Proud. Attendance: 216.

March 8. Talk: Ship Power Plants by J. E. Frelinger, student. Attendance: 175.

Washington State College, March 3. Speaker: Dr. Hacker. Subject: Equality of Gravitational and Inertial Mass. Attendance: 60.

Wayne University, March 9. Speakers: R. L. Place and J. Clayton. Subject: Use of Abrasives in Industry. Film: Romance in Industry, on this subject. Attendance: 53.

University of Wisconsin, Feb. 22. Speakers: Mr. Beadle and Mr. Newton. Subjects: Obtaining and Interpreting High-Speed Diesel Indicator Cards; and Calculation, Testing, and Control of Torsional Vibration. Attendance: 81.

Worcester Polytechnic Institute, March 8. Speaker: S. W. Jones. Subject: The Place of Plastics in Industry. Attendance: 25.

ASME Sections

Coming Meetings

Akron-Canton: May (no date). Canton-Alliance Area. Inspection trip. May 26. Subject: Lost Wax Process of Precision Casting. Speaker to be announced.

Anthracite-Lehigh Valley: May 27. Easton Meeting. Motion Pictures in Industry.

Baltimore: May 23. Engineers Club of Baltimore. Aviation Meeting. Sponsor: L. H. Herbert.

Boston: May 26. Social Meeting.

Central Indiana: May 27. Lincoln Hotel, Indianapolis, Ind., at 6:30 p.m. Subject: Archery, by Forrest Nagler, vice-president, ASME Region VI. Subject: The Engineer's Contribution, by James M. Todd, president of ASME.

Chattanooga: May 13. Maypole Restaurant. Subject: American and Foreign Marine Boilers. Speaker: J. R. Kruse.

Hartford: May 2–4. New London, Conn. National Spring Meeting. May 17. Field trip. South Meadow Plant, Hartford Electric Light Co. at 8 p.m.

Kansas City: May 12. University Club at 8:00 p.m. Ladies night. Guest speaker to be announced.

Metropolitan Section: May 6. President's night, Room 501[1] at 7:30 p.m. Subject: Sulphur and Its Production, by James M. Todd, president, ASME. Following President Todd's talk, refreshments will be served in Room 502.[1] Everyone is welcome.

May 12. Power Division, Room 502[1] at 7:30 p.m. Subject: Latest Technique for Quick Starts on Large Turbines and Boilers, by J. C. Falkner, manager, electric production department, D. W. Napier, general superintendent, Waterside Station, C. W. Kellstedt, assistant general superintendent, Sherman Creek Station, all of Consolidated Edison Co. of N. Y., Inc.

May 12. Woman's Auxiliary, Annual Guest Night and Dinner for members, their families and friends, Engineering Woman's Club, 2 Fifth Ave., New York, N. Y. Cocktails 6 p.m., Dinner 7 p.m. $3 per person.

May 17. Junior Group, Room 501[1] B&C, 7:30 p.m. Subjects: Dynamic Seals and Joints for Radar and Allied Equipment, by A. Razdowitz, and Fatigue of Metals at Supersonic Speeds, by G. Found.

May 20. Joint Meeting ASME Metropolitan Section and American Rocket Society, Room 502[1] at 7:30 p.m. Subject: History of Rockets in the United States, by Dr. G. E. Pendray, Pendray and Liebert.

Minnesota: May 4. Inspection trip to Northwest Airlines' Overhaul Base, St. Paul Airport.

Peninsula: May 10. Auditorium of the Grand Rapids Public Museum. Subject: Profilometer or similar subject, by Dr. Abbott, Physicists Research Co., Ann Arbor, Michigan.

Plainfield: May 18. Elks' Club, Elizabeth, N. J. Ladies' night.

St. Louis: May 20. Joint Meeting with Washington University Student Section.

San Diego Sub-Section (Southern California Section): May 18. San Diego Women's Club. Subject: Experience of a Mining Engineer in Russia. Speaker to be announced. Refreshments.

May 30. Field trip to Palomar Mountain to inspect the 200-inch telescope. Picnic arranged by the committee.

Southern California: May 4. Hydraulic Division. California Institute of Technology, Pasadena. Subject: Valve Location and Installation, by R. E. Hemborg.

May 4. Management Division. 601 West 5th St., Los Angeles. Subject: Systematization, by E. Favary.

May 4. Professional Division. 601 West 5th St., Los Angeles. Subject: 1950 Section Activities, by J. S. Earhart.

May 6. Field trip. U. S. Spring and

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[1] Engineering Societies Building, New York, N. Y.

Bumper Co., 4951 Alcoa Ave., Vernon, Calif.

May 11. Gas Turbine and Heat Transfer Division, 601 West 5th St., Los Angeles. Subject: Temperature Measurement of Jet-Engine Gases, by C. M. Wolfe.

May 11. Photographic Division. 601 West 5th St., Los Angeles. Subject: Template Reproduction, by A. L. Ground.

May 11. Hydraulic Division. California Institute of Technology, Pasadena. Subject: Pump Theory and Practice, by P. Brown.

May 18. Instruments and Regulators Division. 601 West 5th St., Los Angeles. Subject: Instruments and Controls, by J. C. Groenewegen.

May 18. Hydraulic Division. California Institute of Technology, Pasadena. Subject: Piping Theory and Design, by W. O. Wagner and P. Kyropoulos.

May 25. Applied Mechanics Division. 601 West 5th St., Los Angeles. Subject: Dynamic Stability, by J. Miles.

May 25. Hydraulic Division. California Institute of Technology, Pasadena. Subject: Pneumatic Systems, by J. L. Dooley.

May 25. Management Division. 601 West 5th St., Los Angeles. Subject: Leadership, by E. Favary.

Trenton Sub-Section: May 16. Social Meeting, followed by short business session for election of officers.

Virginia: May 13–14 in Norfolk. Joint Meeting of Founder Societies and Engineers Club of Hampton Roads.

Youngstown: May 12. Annual Meeting. Introduction of new officers. May 26. Manufacturing. Subject and speaker to be announced.

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., which is under the joint management of the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to members and is operated on a co-operative nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrants whose notices are placed in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available to members of the co-operating societies at a subscription of $3.50 per quarter or $12 per annum, payable in advance.

New York	Chicago	Detroit	San Francisco
8 West 40th St.	84 East Randolph Street	100 Farnsworth Ave.	57 Post Street

MEN AVAILABLE[1]

MECHANICAL ENGINEER, graduate 1943; experience in textile and plastics-manufacturing maintenance, new design, improved methods, process, steam, water, and air piping, ventilation, and some construction. Me-403.

PLANT ENGINEER, 30, married, mechanical-engineering graduate, 1941; two and a half years general plant maintenance, including job estimation, surveying, production, plant construction. Five years aircraft-engine maintenance. Prefers United States. Me-404-489-D-6.

MECHANICAL ENGINEER, 23, single, desires position overseas. Test engineering on gas turbines two and a half years; planning, supervising, reporting tests involving combustion and heat transfer. Prefers work related to power or fuels. Me-405.

MECHANICAL ENGINEER, married; PE license. Four years' experience on power and chemical plants. Diversified experience in production problems for metal and paper industries. Desires position as sales or assistant engineer. Me-406.

ENGINEER, 34, registered PE; production and plant engineering; design chemical-process equipment, tablet presses, welded-steel-plate construction, ceramic equipment. Desires position as assistant chief engineer, chief draftsman, or salesman. Prefers Philadelphia area. Me-407.

INDUSTRIAL ENGINEER, BSME, graduating MS in IE June. Seeks employment of diversified nature with progressive organization; familiar with systems and cost control. Prefers Chicago area. Me-408.

MECHANICAL ENGINEER, BS degree; married; six years' experience aircraft instrumentation including electric and electronic instruments in service, product, research capacities. Prefers New York City vicinity. Me-409.

INDUSTRIAL ENGINEER, experienced in installation of production-control and inventory-control systems; plant layout; materials handling; labor relations, and contract negotiations. Background in metal fabrication. Interested in small-plant operation. Me-410.

MECHANICAL AND PRODUCTION ENGINEER, 30, executive with machine-tool or domestic-equipment companies, good organizer, proved ability, versatile, and reliable, desires position with American manufacturers intending to establish factories in Great Britain. Resident, London, England. Me-411.

MECHANICAL ENGINEER, 33, BSME, N.Y.U. Twelve years' operational and supervisory experience in food processing, metals, plastics, leather-goods industries. Production-control methods, building and equipment maintenance, layout, materials handling, foremen training. Me-412.

MECHANICAL ENGINEER, young, family, with six years' varied experience, desires position offering unlimited opportunity. Previous positions have offered exceptional security but not the chance to really succeed. Prefers New York, metropolitan area. Me-413.

INDUSTRIAL ENGINEER, Cornell, graduating in June, 1949; desires a position in the East. Special interest in time-and-motion or materials-handling work. Available Sept. 6, 1949. Me-414.

RECENT GRADUATE, BME, with good scholastic record; some design experience. Prefer air-conditioning and refrigeration field, but will take any position with future. Me-415.

POSITIONS AVAILABLE

EXECUTIVE VICE-PRESIDENT, not over 45, for large water-operating company. Should be thoroughly experienced in the operation of water properties. Should be a good organizer and a good administrator. $13,000–$15,000. New York, N. Y. Y-861.

SENIOR MECHANICAL ENGINEER, graduate, with not less than ten years' experience in design and operation of hydraulic turbines, penstock valves, and associated power-plant accessories. Work involves mechanical-plant layout, preparation of specifications, examination of manufacturer's drawings, and inspection of equipment. Salary open, dependent on qualifications. Canada. Y-1721.

SALES ENGINEER, 30–35, for industrial field related mostly to processing and control of fluids. Prefer man now employed either selling mechanical specialties to plants, or employed in a plant in engineering or operating capacity but desirous of entering sales work. Previous sales experience not necessary if man has good background in process equipment such as chemical or power. Write stating qualifications. New York, N. Y. Y-2223.

PROCESS ENGINEER, 30–40, mechanical graduate, with alloy metals, methods, and processing experience, to devise machining and fabrication of nonferrous metals. $6000–$7000. Upstate New York. Y-2225.

JUNIOR INDUSTRIAL ENGINEER, with at least two years' experience in time study, methods, and cost analysis, covering plate and pressure-vessel fabrication for staff position with heavy-chemical-equipment manufacturer. $3600. Northern New Jersey. Y-2230.

GENERAL MANAGER EXECUTIVE VICE-PRESIDENT, 40–50, for large manufacturing company in heavy industry, to take charge of and establish management policies including sales. $25,000–$50,000. Midwest. Y-2233-R-5615.

CHIEF INDUSTRIAL ENGINEER, 35–45, graduate, IE or ME, with five years' experience in production control, time study, standards, plant layout, etc., to head up department for electrical-products manufacturer.

(ASME News continued on page 458)

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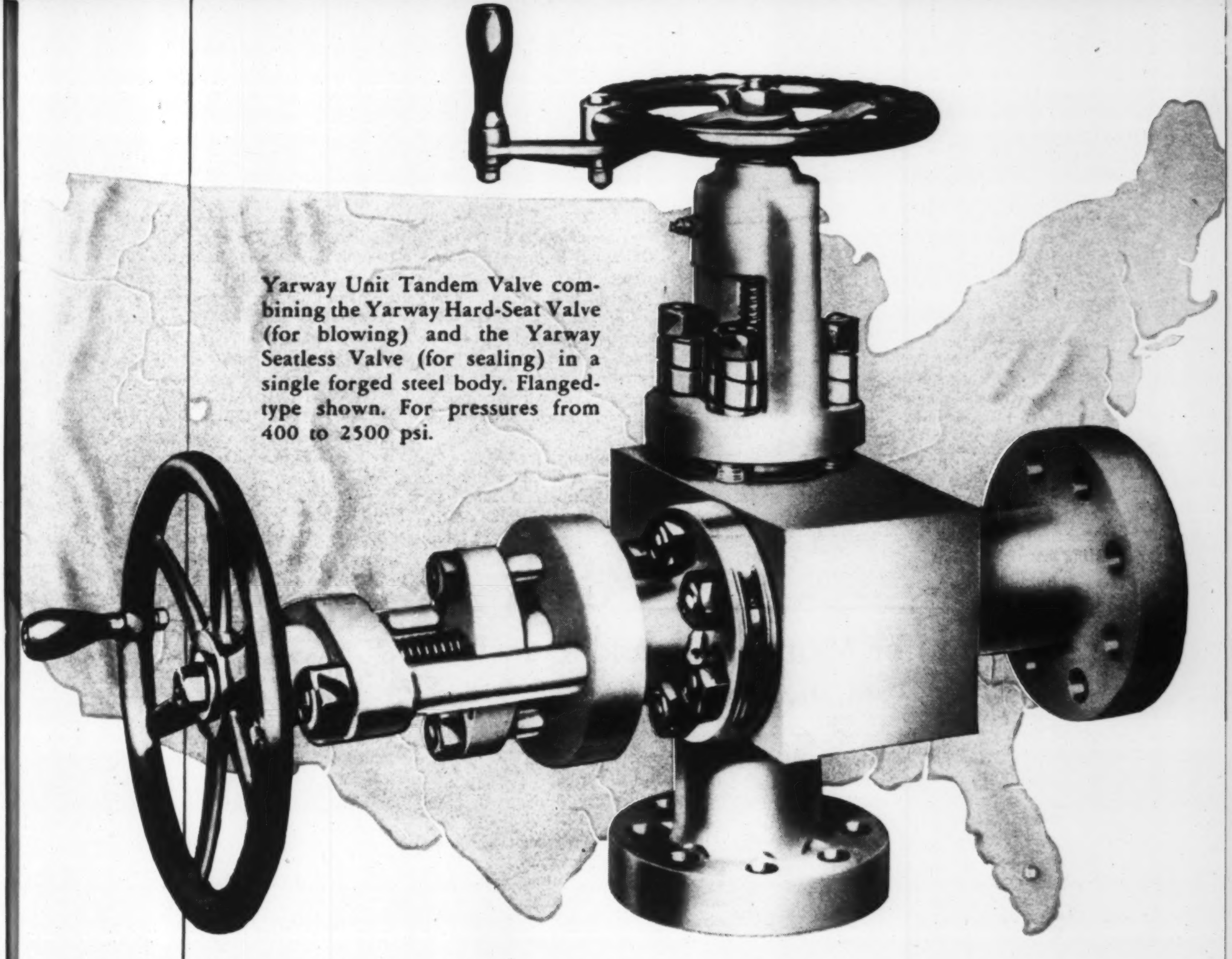
[1] All men listed hold some form of ASME membership.



Yarway Unit Tandem Valve combining the Yarway Hard-Seat Valve (for blowing) and the Yarway Seatless Valve (for sealing) in a single forged steel body. Flanged-type shown. For pressures from 400 to 2500 psi.

NORTH
WEST
EAST
SOUTH

it's YARWAY 4 to 1

From every corner of the country comes the same story—four out of every five high pressure boiler plants are equipped with Yarway Unit Tandem Blow-Off Valves.

Each day's orders add to the evidence. From Ohio . . . 17 new Yarways, making a total of 746 purchased by this large utility over the last 35 years. From California . . . 10 new Yarway Unit Tandems for one company, 9 for another. Texas sends an order of 5 . . . 3 for one new municipal plant, 2 for another. Northern New York wants 7 for new boilers in a well-known utility. And so it goes.

Why this overwhelming preference?

Proved dependable performance, due to outstanding design, sound engineering and careful manufacture . . . plus constant research, leading to mechanical and metallurgical advancements that keep Yarway Valves ahead of changing service requirements.

For latest information on Yarway Unit Tandem Blow-Off Valves, write for Yarway Bulletin B-432.

YARNALL-WARING COMPANY
108 Mermaid Avenue, Philadelphia 18, Pa.

YARWAY BLOW-OFF VALVES

$6500–$7500. New York metropolitan area. Y-2234.

Engineers. (a) Development engineer with electronic instrument and servomechanism experience for aeronautical-instrument laboratory. Salary open. (b) Laboratory technician with electronic experience in aircraft instruments and allied fields. Salary open. New York metropolitan area. Y-2237.

Mechanical Maintenance Superintendent, mechanical graduate, 40–45, with at least ten years' maintenance experience with automotive, conveyers, ventilation, and general building-equipment experience, to take charge of municipal. building equipment. $9000. New York, N. Y. Y-2262.

Executive Assistant, 30–35, mechanical graduate, with five years' production and supervisory manufacturing experience in chemical, pulp and paper, steel processing, etc., for staff position with manufacturer of building materials. $10,000. East. Y-2278.

Assistant Sales Manager, 35–40, mechanical graduate, with experience in steam specialties and heat-exchanger sales and engineering, to direct sales force and advertising, both space and direct mail. $6000 a year plus bonus. Western New York State. Y-2293.

Hydraulic Designing Engineer, preferably with experience in the design and development of hydraulic equipment. Should have sufficient experience background to enable him to develop new projects, for a manufacturer of hydraulic-control equipment seeking to augment present staff. Excellent opportunity in an organization with retirement, vacation, and insurance plans. Salary open. Michigan. D-4807.

Mechanical Engineer, graduate, with substantial experience in plumbing, heating, and ventilating. Will lay out, plan, and work independently on industrial building for architectural firm. Salary open. Illinois. R-5593.

Candidates for Membership and Transfer in the ASME

The application of each of the candidates listed below is to be voted on after May 25, 1949, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

Re = Re-election: Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member.

NEW APPLICATIONS

For Member, Associate, or Junior

Anderson, Warren L., Detroit, Mich.
Arnold, Alanson J., New Orleans, La.
Astill, Kenneth N., Medford, Mass.
Babbitt, H. Z., Rapid City, S. Dak.
Bacon, Howard L., Laconia, N. H.
Barnes, Thomas Branson, Philadelphia, Pa.
Barngrover, P. M., Laguna Beach, Calif.
Beecher, John D., Bristol, Conn.
Bell, Robert Arthur, Chicago, Ill.
Berglund, Niels W., Los Angeles, Calif. (Rt & T)
Bernstein, Murray, Brooklyn, N. Y.
Bhooshanarao, P. V. B., Louisville, Ky.
Binford, Harry A., Birmingham, Ala.
Bohmke, Warren F., Chicago, Ill.
Bomer, Pieter A., Bayside, N. Y.
Bowen, Carl R., Los Angeles, Calif.
Brown, Robert C., New York, N. Y.
Cameron, A. Pollock, Greensburg, Pa.
Chapman, Cyril T., Bala-Cynwyd, Pa. (Rt)
Chartier, Edmund G., Natick, Mass.
Clancy, Gilbert Eugene, Los Angeles, Calif.
Cohn, Herbert Albert, Swissvale, Pittsburgh, Pa. (Rt)
Cook, A. J., Harriman, Tenn.
Danforth, P. O., Ann Arbor, Mich.
Darnell, D. W., Altadena, Calif.
Davis, Jerome I., Brooklyn, N. Y.
de Castro, Edson E., W. Newton, Mass. (Rt & T)
Delabar, Martin T., Winston-Salem, N. C.
Dickson, J. D., Portland, Ore.
Dolan, Joseph Francis, Milton, Mass.
Duncan, Richard L., West Lafayette, Ind.
Elledge, Everard A., E. Foxboro, Mass.
Ellen, Bruce P., Port Wentworth, Ga.
Erickson, Lester Henry, Los Angeles, Calif.
Esclangon, Felix, Grenoble, Isère, France
Evers, Edward P., Jr., St. Louis, Mo.
Farrow, Joe Perry, Tulsa, Okla.
Faulkner, W. W., Meridian, Miss.
Fetterolf, Warren R., Dunmore, Pa.
Fisher, Sylvester James, Rock Springs, Wyo.
Fleck, Frank A., El Segundo, Calif.
Flindle, Albert, Audenshaw, nr. Manchester, England
Fossett, Hubert, Norwich, Cheshire, England
Francis, R. J., Granville, Ohio
Freudenstein, Ferdinand, Buffalo, N. Y.
Frivance, John William, Washington, N. C.
Ganapathy, S., Denver, Colo.
Geraldine, Desmond Gavin, South Pasadena, Calif.
Goodrich, Paul L., Dorchester, Mass.
Gould, Philip H., Dallas, Pa.
Gruber, Alan R., Elmhurst, N. Y.
Gunsaulus, Robert K., Royal Oak, Mich.
Hall, Stuart P., Lake Orion, Mich.
Hansen, H. S., Los Angeles, Calif.
Hashizume, Toshio T., Ventnor City, N. J.
Heiser, George H., Campbell, Calif. (Rt & T)
Herrick, David B., Jeannette, Pa.
Hibberd, F. H., New York, N. Y.
Hilker, Donald Henry, Indianapolis, Ind.
Hopkins, Richard S., Kearny, N. J. (Rt)
Jacoby, G. A., Hamilton, Ohio
Jados, Walter Thomas, Berwyn, Ill.
Jones, E. E., Glendale, Calif.
Jones, Richard F., Reading, Pa.
Kelly, John T., Chicago, Ill. (Rt & T)
Kohn, Elliott Storch, New York, N. Y.
Kristensen, Henning, Sewell, Rancagua, Chile, South America
Lawrence, Robert, Jr., New York, N. Y.
Lemieux, David, Chicago, Ill.
Levitan, Maurice D., Barberton, Ohio
Lidon, Joseph, Elizabeth, N. J.
Lindahl, Carl O., Los Angeles, Calif.
Lockwood, Norman R., Jackson Heights, N. Y.
Lyons, Carl J., Columbus, Ohio
Malin, J. Brent, Whittier, Calif.
Marquardt, Roy E., Van Nuys, Calif.
Marshall, Donald M., Manchester, Conn.
Masser, Harry L., Los Angeles, Calif. (Rt)
Mathewson, C. Douglas, Jersey City, N. J.
McBee, Darwin L., Rapid City, S. Dak.
Moskal, Francis, Toronto, Ont., Can.
Nandah, Steven, San Fernando, Trinidad, B. W. I.
Nekola, Harry O., Cleveland Heights, Ohio
Nelson, Joyce A., San Francisco, Calif.
Newman, S. A., Pittsburgh, Pa.
Nieboer, Hendrik A., Toronto, Ont., Can.
Notra, D. S., P. O. Sri Ganga Nagar, Bikaner State, India
Oberg, Carl M., Dorchester, Mass.
O'Brien, Charles C., Youngstown, Ohio
Page, Arvin, Winston-Salem, N. C. (Rt)
Palmer, W. G., Compton, Calif.
Parmakian, John, Denver, Colo. (Rt & R)
Paulovich, Kenneth F., Berkeley, Calif.
Peabody, John E., Miami, Fla.
Peppermiller, Arthur F., Los Angeles, Calif.
Perkins, Delbert E., Lawrence, Kan.
Poulsen, Alfred E., Los Angeles, Calif.
Pratt, W., Port Chester, N. Y.
Reethof, Gerhard, Great Neck, N. Y.
Rockowitz, Seymour B., Cleveland, Ohio
Rogers, Robert W., Providence, R. I.
Rosen, Theodore, New York, N. Y. (Rt)
Ross, Irving, D., Jr., Chicago, Ill.
Russell, Thomas W., Los Angeles, Calif.
Schmidt, Robert V., Long Beach, Calif.
Schreiber, Leonard H., Bronx, N. Y.
Schubert, Julius, Brooklyn, N. Y.
Scortecci, Antonio, Genova, Italy
Scroxton, Richard R., New York, N. Y.
Sellers, Don, Inglewood, Calif.
Simonitsch, F. J., Cincinnati, Ohio
Skweir, Eugene Alexander, Milton, Pa.
Spann, William Stirling, Baton Rouge, La.
Spencer, G. F., Jackson Heights, L. I., N. Y.
Sprague, Ben C., New York, N. Y.
Spransy, George B., Milwaukee, Wis.
Stangleland, Ole Ingvaldsen, Chicago, Ill.
Stensaas, Elden R., Rapid City, S. Dak.
Steyer, Cyril Dean, West Lynn, Mass.
Stoyke, Ludwig T., Rockford, Ill.
Street, George, Jr., Schenectady, N. Y.
Sullivan, Daniel J., Cambridge, Mass.
Sundeen, Carl J., Anderson, Ind.
Sykes, Clarke C., Toledo, Ohio
Tallon, William S., York, Pa.
Taylor, Arthur W., Lincolnwood, Ill.
Tomlin, Samuel Stokes, Jr., Atlanta, Ga.
Torchio, Philip, Jr., Bronxville, N. Y. (Rt & T)
Utecht, Everett A., Kent, Ohio
Vail, Herbert P., S. San Francisco, Calif.
von Soden, A. F. G., Los Angeles, Calif.
Wall, William E., Miami, Fla.

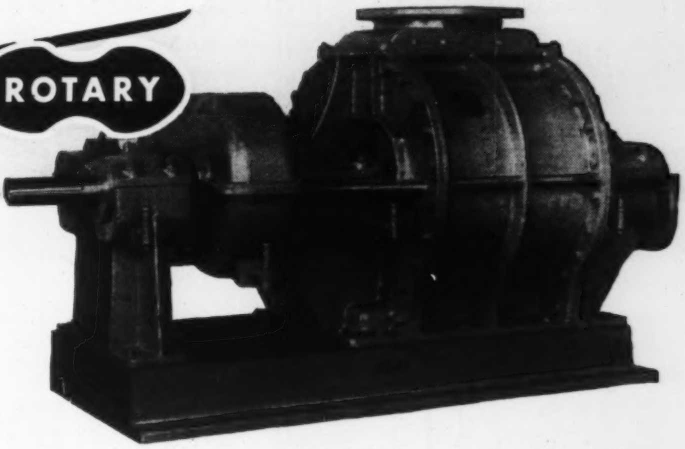
(*ASME News continued on page 460*)

CENTRIFUGAL

R-C dual-ability plays no favorites!

Battery of five R-C multi-stage Centrifugal Gas Exhausters driven by steam turbines.

ROTARY



Standard Rotary Positive Blower, Type RCD, built in 8" to 22" gear diameters.

With a wide choice of Centrifugal and Rotary Positive Blowers available, you can usually select standard R-C units to meet your specific applications. Capacities range from 10 CFM to 50,000 CFM or higher for special requirements. Roots-Connersville is the only blower manufacturer offering you this *dual choice.*

We're impartial as to drives, too. We supply them or you can utilize drives already available. Direct motor, speed changer or V-belt, steam turbine, gas engine or other modern types provide high-efficiency operation for R-C units. That's another phase of R C *dual-ability.*

With R-C equipment on the job, you'll enjoy long-time, trouble-free performance. That's because of sound design and sturdy construction, based on 95 years of building gas and air handling equipment, *exclusively.* For any such problem, you are free to consult R-C *dual-ability.*

ROOTS-CONNERSVILLE BLOWER CORPORATION
905 Michigan Avenue, Connersville, Indiana

ROOTS-CONNERSVILLE

BLOWER BUILDERS R-C SINCE 1854

BLOWERS • EXHAUSTERS • BOOSTERS • LIQUID AND VACUUM PUMPS • METERS • INERT GAS GENERATORS

* * **ONE OF THE DRESSER INDUSTRIES** * *

FOR HANDLING GAS OR AIR, CALL ON *R-C dual-ability*

Roots-Connersville builds the most extensive line of gas or air-handling equipment.

Centrifugal and Rotary Positive Blowers, Exhausters, Boosters

•

Rotary Liquid and Vacuum Pumps

•

Positive Displacement Meters

•

Inert Gas Generators

•

Send for descriptive bulletins or write us details of your specific requirements.

Wardlaw, Russell, San Francisco, Calif.
Weiler, John L., Freeport, L. I., N. Y.
Whalen, John William, Los Angeles, Calif.
Wheater, Richard I., Valley Stream, N. Y.
Winter, Frederick W., Temple, Texas
Wolfson, Lawrence, Brooklyn, N. Y.
Yeager, Ulysses B., Huntington, W. Va.
Yingst, C. S., Malverne, L. I., N. Y.
Zink, J. H., Jr., Baltimore, Md.
Zurn, John Henry, Erie, Pa.

CHANGE IN GRADING

Transfer to Member

Bates, Ralph E., Chicago, Ill.
Bogard, Ben T., Ruston, La.
Brown, R. A., Compton, Calif.
Carlson, David, New York, N. Y.
Evans, B. G., Indianapolis, Ind.
Frost, George H., Ames, Iowa
Hamilton, John S., White Plains, N. Y.
Koechlein, George J., Springfield, N. J.
Kramer, Alexander C., Inglewood, Calif.
Mahen, K. W., New York, N. Y.
McQuadie, Louis, Charleston, W. Va.
Modes, E. E., Chicago, Ill.
Montresor, Joseph J., Hillsdale, N. J.
Nelson, Lloyd S., Aberdeen, Md.
Peterson, F. W., Ligonier, Pa.
Poor, Albert F., Jr., Baton Rouge, La.
Pozniak, Victor P., Lynn, Mass.
Reitman, Arnold, Brooklyn, N. Y.
Reuschlein, Clifford Joseph, Madison, Wis.
Stalder, J. R., Los Altos, Calif.
Toone, James Ann, Jr., Fayetteville, Ark.
Warren, Mead, Jr., Maryville, Tenn.

Transfers from Student Member to Junior..... 550

Obituaries

Charles Joseph Bailey (1896–1949)

Charles J. Bailey, formerly sales engineer, Bridgeport (Conn.) Brass Co., died Jan. 18, 1949. Born, Lancaster, Pa., Aug. 15, 1896. Parents, Mr. and Mrs. John Bailey. Education, six-year extension course, Northeastern College. Jun. ASME, 1921; Assoc. ASME, 1923; Mem. ASME, 1935.

Ellis Crain Baker (1889–1949)

Ellis Crain Baker, professor of mechanical engineering, head of mechanical-engineering department, Oklahoma A&M College, died in Feb., 1949. Born, Brandon, Miss., Feb. 1, 1889. Parents, Arthur Gibson and Sarah Frankie (Crain) Baker. Education, BS, Mississippi State College, 1911; MSME, Iowa State College, 1930. Married Emma Pearson Davis, 1915; children, James Oliver and Ellis Crain, Jr. Mem. ASME, 1929; served on Nominating Committee, Group VIII, 1942; past chairman, Mid-Continent Section 1941–1942.

Charles Foster Bancroft (1873–1948)

Charles Foster Bancroft, retired engineer, died in New Canaan, Conn., on Oct. 25, 1948, of a heart attack. Born, Mansonville, P. Q., Can., Dec. 17, 1873. Parents, Rev. Charles and Eunice (Foster) Bancroft. Education, St. John School; students' course, Edison General Electric Co.; Royal Electric Co., Montreal, Can. Married Cornelia Herriman Dow, 1905. Naturalized, Boston, Mass., 1905. Mem. ASME, 1911. Survived by wife and two children, Charles and Cornelia (Mrs. L. S.) Greene, all of New Canaan, Conn.

William Duis Bell (1889–1948)

William Duis Bell, designer of mechanical equipment, died in Doctors' Hospital, Columbus, Ohio, Nov. 25, 1948. Born, Wheelersburg, Ohio, Dec. 2, 1889. Parents, George Alexander and Elizabeth (Duis) Bell. Education, Wheelersburg High School, special courses, Ohio State University. Married Helen L. Albright, 1930. Mem. ASME, 1940. Survived by wife. They had no children.

Lewis Fisher Brown (1879–1949)

Lewis F. Brown, retired engineer, died in Lynchburg, Va., on Jan. 25, 1949. Born, Pembroke, Me., Dec. 27, 1879. Parents, Edwin K. and Emma (McGlauflin) Brown. Education, Georgia Institute of Technology; New York University. Married Cornelia Hefferman (deceased); child, Emma (deceased). Married 2nd, Eva Tolley McIlhenny. Mem. ASME, 1930. Survived by wife and four stepchildren.

Howard Benton Craig (1870–1948)

Howard Benton Craig, retired in 1944 by the Solvay Process Co., died on March 20, 1948, in Solvay, N. Y. Born, Wilmington, Del., Feb. 26, 1870. Parents, Thomas Benton and Ellen Conover (Tindall) Craig. Education, high-school graduate; Wilmington Drawing Institute. Married Mabel H. Garrett, 1902. Jun. ASME, 1899. Survived by wife.

Horace Silliman Gulick (1885–1949)

Horace Silliman Gulick, assistant to the first vice-president, New York Air Brake Co., and president, Watertown (N. Y.) Chamber of Commerce, died suddenly of a coronary thrombosis, Feb. 8, 1949, while presiding at the 47th annual meeting of the chamber of commerce. Born, Orlando, Fla., Dec. 31, 1885. Parents, William R. and Hermione (Silliman) Gulick. Education, BS, Oklahoma A&M College, 1903. Married Hazel Anne Bromley, 1918. Mem. ASME, 1945. Survived by wife, a son, Harry Bromley; a daughter, Ann Wyckoff, junior at Mount Holyoke College; and a stepsister, Mrs. Albert Jackson, Dunkirk, N. Y.

Robert Childs Harmon (1918–1948)

Robert C. Harmon died at Firland Sanatorium on Oct. 3, 1948, following a long illness. He was last employed as an engineer by the Isaacson Iron Works, Seattle, Wash. Born, Tacoma, Wash., March 4, 1918. Parents, George and Cora (Childs) Harmon. Education, BSME, University of Washington, 1944. Married Mary Lou Distad 1943. Jun. ASME, 1944. Survived by wife.

Maurice Hoopes (1870–1949)

Maurice Hoopes, chairman, board of directors, Finch, Pruyn and Co., Inc., manufacturers of newsprint paper, died at his home in Glens Falls, N. Y., on Feb. 15, 1949. Born, West Chester, Pa., Oct. 16, 1870. Parents, Thomas and Amanda (Russell) Hoopes. Education, private schools; Cornell University. Married Mary Eliza Pruyn, 1901; children, Samuel Pruyn (deceased, 1934) and Mary Pruyn. Mem. ASME, 1901. Survived by wife and daughter, Mrs. Lyman A. Beeman; two brothers, Arthur and Charles, both of West Chester, Pa.; and four grandsons.

Albert Andrew Jackson (1891–1949)

Albert Andrew Jackson, project engineer, Chicago Pneumatic Tool Co., died in Franklin, Pa., Jan. 29, 1949, of a heart attack. Born, Cooperstown, Pa., Feb. 11, 1891. Parents, Homer C. and Mary (McIntosh) Jackson. Education, public schools and private study. Married Ruth Allison. Jun. ASME, 1921; Assoc., 1926; Mem., 1935. Survived by wife.

Gustaf Leonard Kollberg (1878–1949)

Gustaf L. Kollberg, retired Allis-Chalmers executive, engineer, died Feb. 2, 1949, at his home in Milwaukee, Wis. Born, Ljusne, Sweden, March 25, 1878. Education, mechanical course, Chicago Business and Trade College, 1896. Mem. ASME, 1901; served on Power Test Codes Committee, Reciprocating Steam-Driven Displacement Pumps, 1937–1947. Survived by wife, a daughter, and a son, Paul G., who is an engineer with the Atomic Energy Commission's Argonne Laboratory, Chicago, Ill.

Arthur George Leonard (1862–1949)

Arthur G. Leonard, president, The Union Stock Yard and Transit Co., died at his home in Chicago, Ill., on Feb. 4, 1949. Born, New York, N. Y., Aug. 8, 1862. Parents, Arthur George and Eliza (Farlow) Leonard. Married Mary Josephine Ashley (died, July 4, 1930). Mem. ASME, 1890. Survived by four children, Mrs. Dorothy Leonard Ellis, Wayne, Ill., Mrs. Carleton B. Swift, Pasadena, Calif., Edward Ashley Leonard, Chicago, Ill., and Arthur G. Leonard, Jr., Wilmington, Ill.

George Phillip Semple (1918–1948)

George P. Semple, engineer, Hydraulic Press Manufacturing Co., Mt. Gilead, Ohio, died of multiple sclerosis at his home in Detroit, Mich., on Sept. 20, 1948. Born, Chicago, Ill., Aug. 7, 1918. Parents, James Reid and Mae (Walker) Semple. Education, BSE, Princeton University, 1940; ME, Chrysler Institute, 1942. Married Rose Lynn Ernst, 1941. Jun. ASME, 1940. Survived by wife and son, James Reid Semple, and parents.

Hugh Lindsay Thompson (1863–1949)

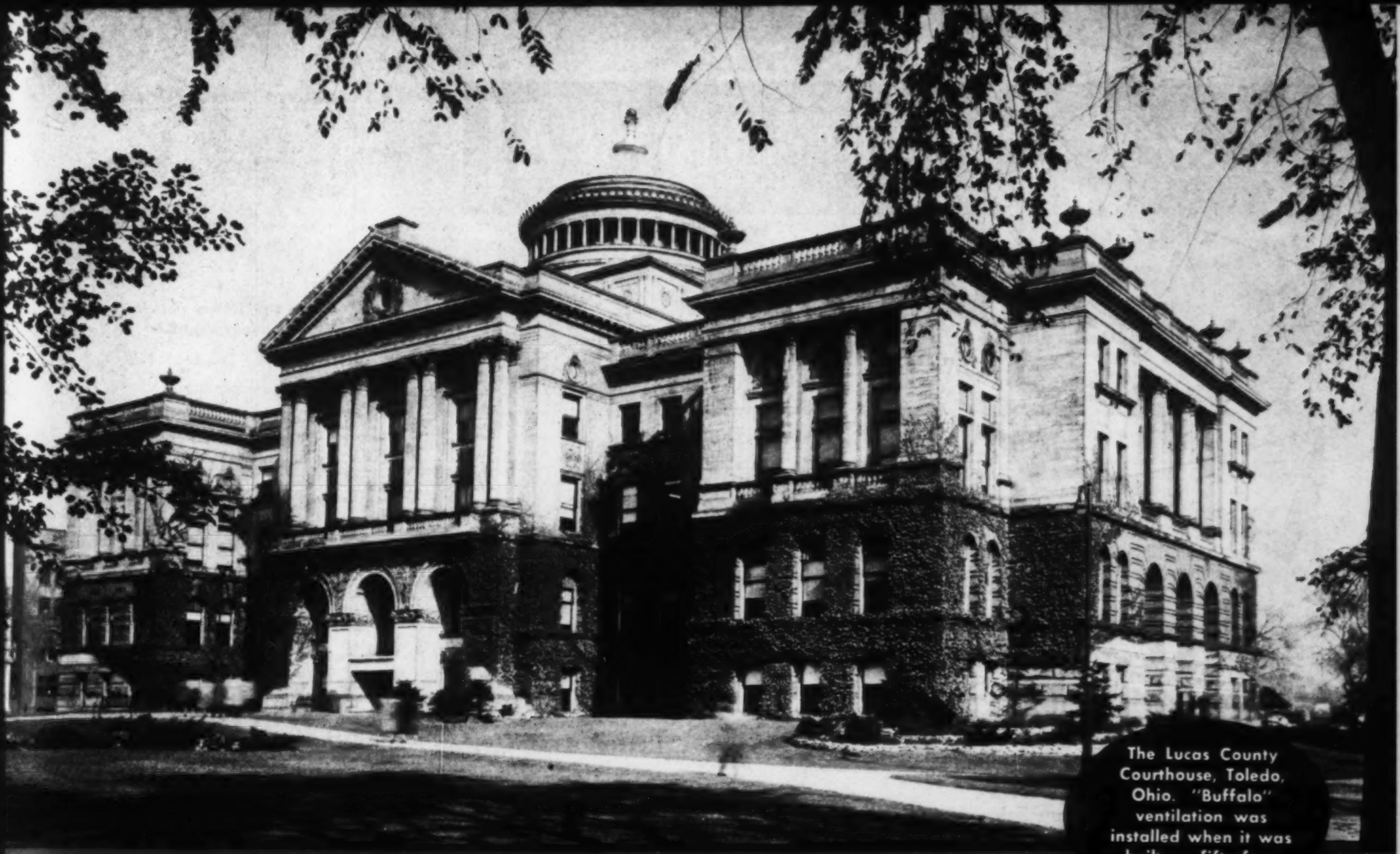
Hugh L. Thompson, consulting engineer, died in the Waterbury (Conn.) Hospital after an illness of two months on Feb. 14, 1949. Born, Thistle, Md., Dec. 8, 1863. Parents, Robert and Margaret Helen (Bone) Thompson. Education, private schools. Married Caroline Goss, 1900. Mem. ASME, 1894. Surviving are his wife and two daughters, Caroline G. Thompson, Madison, Wis., and Mrs. Helen T. McKenney, Putney, Vt.; and three sisters.

Sanford Eleazer Thompson (1867–1949)

Sanford E. Thompson, engineer, president, The Thompson and Lichtner Co., Inc., Boston, Mass., died in Phoenix, Ariz., Feb. 25, 1949. Born, Ogdensburg, N. Y., Feb. 13, 1867. Parents, Eleazer and Harriet Newell (Sanford) Thompson. Education, BSCE, Massachusetts Institute of Technology, 1889. Married Stella Antoinette Converse, 1900 (deceased); children, Katherine Converse (deceased), Marion (Mrs. Ward Beckwith), David Sanford Taylor (deceased), and Dr. Dorothy Dewhurst. Married 2nd, Frances Lord Marsh, 1947. Mem. ASME, 1909; Fellow ASME, 1947.

William Monroe White (1871–1949)

William Monroe White, hydraulic engineer, retired chief engineer, and manager of the hydraulic turbine department, Allis-Chalmers Manufacturing Co., died in the Jackson Memorial Hospital, Miami, Fla., Feb. 9, 1949, after a long illness. Born, Valley Head, Ala., Nov. 20, 1871. Education, ME, Tulane University, 1899. Honorary DS, Tulane University, 1930. Mem. ASME, 1906; Fellow ASME, 1943. He served on the Power Test Codes, 1937–1941; Power Test Codes Committee, Centrifugal and Rotary Pumps, 1945; Power Test Codes Committee, Hydraulic Prime Movers, 1945; and Drainage of Coal Mines (M6) 1937. Dr. White was unmarried.



The Lucas County Courthouse, Toledo, Ohio. "Buffalo" ventilation was installed when it was built — fifty-four years ago.

Air of Durability

"Ability to endure or continue in a particular condition; lasting."
— Webster

54 YEARS OF AIR SERVICE

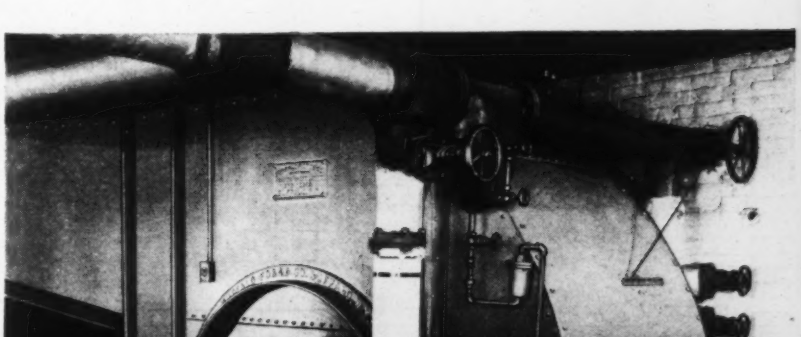
ONE of the most rigorous tests of a fan is that of time. When the fan keeps on delivering decade after decade, then it becomes a truly low-cost piece of equipment — one that has paid for itself many times over.

The "Buffalo" fan illustrated was installed in the Lucas County Court House, Toledo, Ohio, in 1895. This and two other "Buffalo" fans have been supplying ventilation for all fifty-four years of the building's life — and are "still going strong." From many such user-reports of "Buffalo" fans and air conditioning cabinets still on the job after thirty, forty and more years, you know that "Buffalo" equipment lasts!

If you want "Air of Durability" — with all the reliability and economy this implies — specify "BUFFALO."

BUFFALO FORGE COMPANY
118 MORTIMER ST. BUFFALO, NEW YORK
Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

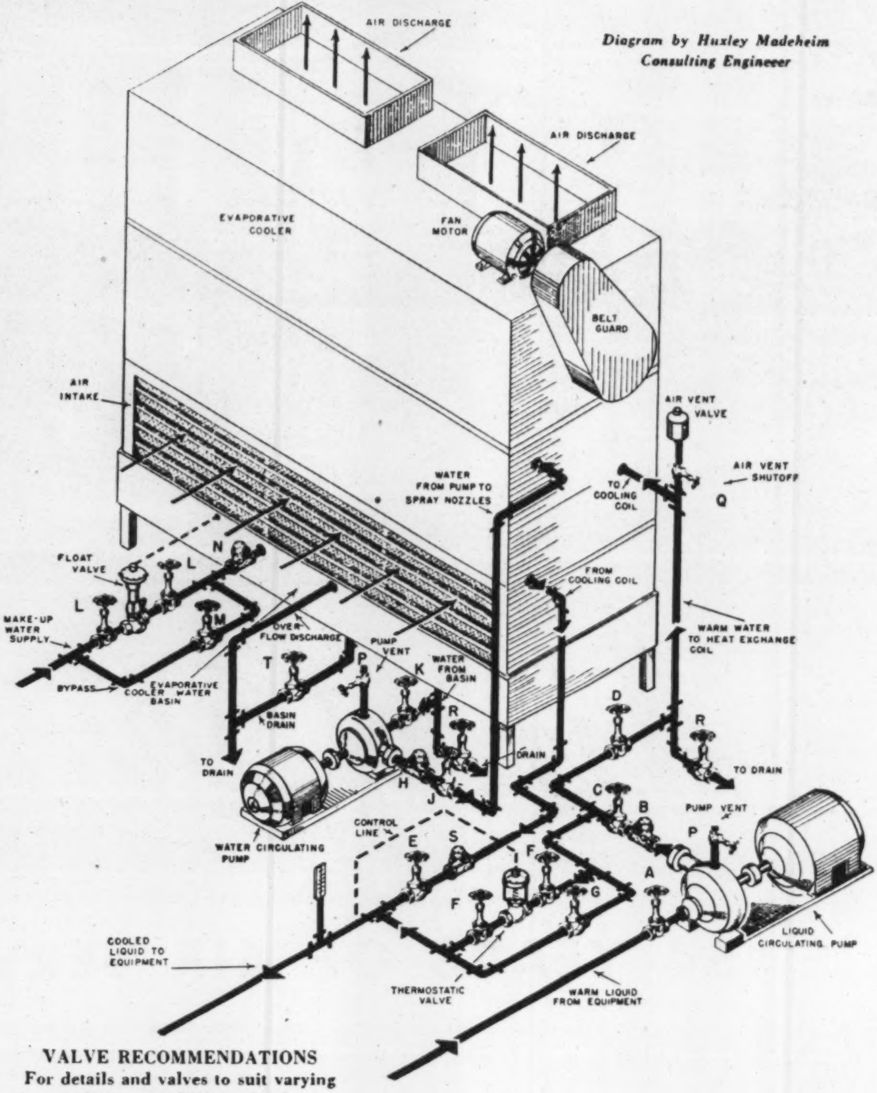
Branch Offices in All Principal Cities



"Buffalo" First For Fans

Jenkins PRACTICAL PIPING LAYOUTS 41

How to plan an EVAPORATIVE COOLER


AIR DISCHARGE
AIR DISCHARGE
EVAPORATIVE COOLER
FAN MOTOR
BELT GUARD
AIR INTAKE
AIR VENT VALVE
AIR VENT SHUTOFF
Q
WATER FROM PUMP TO SPRAY NOZZLES
TO COOLING COIL
FROM COOLING COIL
WARM WATER TO HEAT EXCHANGE COIL
FLOAT VALVE
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MAKE-UP WATER SUPPLY
OVER FLOW DISCHARGE
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R
TO DRAIN
DRAIN
TO DRAIN
H
J
C
B
PUMP VENT
P
CONTROL LINE
E
S
F
F
G
A
WATER CIRCULATING PUMP
COOLED LIQUID TO EQUIPMENT
THERMOSTATIC VALVE
WARM LIQUID FROM EQUIPMENT
LIQUID CIRCULATING PUMP

Diagram by Huxley Madeheim
Consulting Engineeer

Evaporative coolers are used extensively to cool fluids for reuse where water rates are high or the use of water for cooling is restricted. The one illustrated is typical of those used to cool diesel or gas engine jacket water, oil, or any other warm liquid returned to equipment for reuse.

The fluid to be cooled is pumped through coils in the cooler by a circulating pump. Cooling water is sprayed over the coils and a fan speeds up its evaporation. The spray water then drains off the outside of the coil into a basin and returns to the spray nozzles where the cycle is repeated.

If it is necessary to regulate the temperature of the liquid returning to the equipment, a thermostatically controlled bypass line is provided. This allows some warm fluid to be mixed with the cooled fluid returning to the equipment.

Consultation with accredited piping engineers and contractors is recommended when planning any major piping installation. Copies of Layout No. 41, enlarged, with additional information, will be sent on request. Just mail the coupon.

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VALVE RECOMMENDATIONS

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Code	Quan.	Jenkins Valves	Service
A	1	Fig. 47 Bronze Gate	Liquid Circulating Pump Suction
B	1	Fig. 92 Bronze Swing Check	Prevent Backflow to Pump
C	1	Fig. 106-A Bronze Globe	Liquid Pump Discharge Shutoff
D	1	Fig. 47 Bronze Gate	Cooling Coil Intake Shutoff
E	1	Fig. 106-A Bronze Globe	Cooling Coil Discharge Control & Shutoff
F	2	Fig. 47 Bronze Gate	Thermostatic Valve Shutoff
G	1	Fig. 106-A Bronze Globe	Manual Bypass Control
H	1	Fig. 92 Bronze Swing Check	Prevent Riser Drainage
J	1	Fig. 106-A Bronze Globe	Water Circulating Pump Discharge
K	1	Fig. 47 Bronze Gate	Pump Suction Shutoff
L	2	Fig. 47 Bronze Gate	Float Valve Shutoff
M	1	Fig. 106-A Bronze Globe	Manual Water Inlet Bypass
N	1	Fig. 92 Bronze Swing Check	Prevent Make-up Water Contamination
P	2	Fig. 106-A Bronze Globe	Pump Air Vent Shutoffs
Q	1	Fig. 106-A Bronze Globe	Riser Vent Valve Shutoff
R	2	Fig. 106-A Bronze Globe	Drain Valves
S	1	Fig. 92 Bronze Swing Check	Prevent Backflow to Cooling Coil
T	1	Fig. 106-A Bronze Globe	Drain

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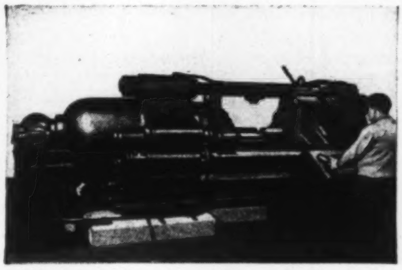
Available literature or information may be secured by writing direct to the manufacturer and mentioning MECHANICAL ENGINEERING as a source.

• *NEW EQUIPMENT*

A New Self-Contained Extrusion Press for Fast and Low-Cost Production

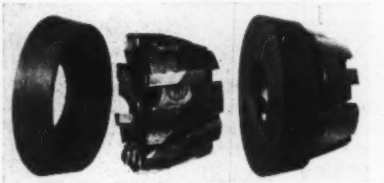
A new type oil-hydraulic extrusion press for rapid and economical production of rods and shapes from light metals and other non-ferrous alloys has been designed by Hydropress, Inc., New York. The self-contained machine which is built in 500 and 1000 tons capacity, requires very little floor space and minimum operating personnel. A production of 50 to 60 billets per hour can easily be obtained.



The increasing demand among the building-, furniture- and similar trades for Aluminum and the other light metal extrusions such as window sections, ladder sides, trim moldings, ornamental and structural shapes, makes this machine especially interesting. The fast working press is designed for accessibility and quick change of dies. This makes it possible to limit production to extruding the shapes actually needed and save the costs of keeping numerous items in stock.

Milling Cutter Guards

The Westinghouse Air Brake Co. is marketing a new product through its Industrial Division, all because one of their tool room supervisors got tired of handling milling cutters—if his hands didn't get nicked the tool did, and he was forever doctoring one or the other.

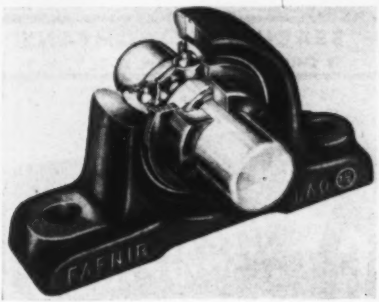


Since the company has its own rubber department, turning out all kinds of gaskets, packing cups and seals for pneumatic and hydraulic devices, the tool man asked them to mold him a few guards. As it turned out the samples not only protected the milling cutters and handlers, but they also stacked and stored easier with savings that soon paid their way all along the line from storeroom to machine.

With everybody happy it wasn't long before an alert salesman from a tool company spotted the guards and added them to his line, cataloging them right along with his milling cutters. Now the Westinghouse Air Brake Co. is supplying a complete line of guards in one inch sizes from 3" to 10" and is prepared to expand manufacture to other sizes as demand develops.

Lao Pillow Blocks

Now in production, a new series of pillow blocks equipped with Fafnir Mechani-Seal Ball Bearings is announced by The Fafnir Bearing Co. Designated as the "Lao" Series, this line is being produced in nine shaft sizes ranging from $1\frac{3}{16}$ to $2\frac{15}{16}$ inches. The "Lao" is the newest addition to the widely used line of Fafnir transmission units.



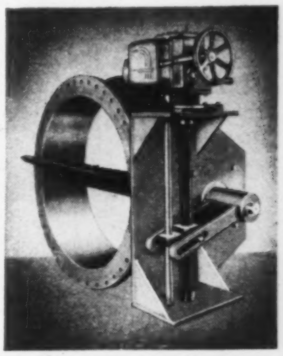
Each "Lao" incorporates a heavy series ball bearing with wide inner ring and exclusive self-locking collar, making installation on a shaft simple and removal easy. The featured Mechani-Seal is a labyrinth type closure plus an external slinger member to throw off contaminants when operating at normal speed. For added protection at low speeds or under adverse atmospheric conditions, a combination synthetic rubber and felt washer has been incorporated as an integral member of the seal.

The bearing has a spherical outside diameter which, when mounted in its corresponding spherical housing, provides unrestricted self-alignment in any direction. The pillow block housing is an extremely compact single piece, reinforced at all stress points.

For further information please contact Truman L. Hunt, Advertising Manager, The Fafnir Bearing Co., New Britain, Conn.

New R-S 50-Pound Valve for Hydraulic Service

R-S Products Corp., Wayne Junction, Philadelphia 44, Pa. has announced the development of a 54-inch 50-pound Iron Valve for hydraulic service and especially for controlling the flow of condenser water. This valve, of extremely rugged construction has 125-pound American Standard flanges and is operated by a limitorque electric motor connected to a threaded reach rod that moves the valve very slowly to prevent water hammer. The threads on the reach rod can be cut for a large variety of speeds ranging from sixty seconds up to eight minutes. It is stated that this type valve is available in larger sizes, for higher pressures and in materials other than iron.



The illustration shows how wedge-type closure is accomplished by the vane or disc. This valve can be fitted with a renewable and replaceable rubber spool for positive 100% shut-off, which will provide bubble-tight shut-off up to 80 psi air and commercially tight shut-off up to 100 psi water.

Proficorder

Physicists Research Co. announces the Proficorder—a mechanical-electronic shop instrument which provides a magnified chart record of the shape, height and spacing of surface irregularities.

This instrument will show the true profile of practically any machined or other surface. It is highly flexible as to the amount of detail recorded; and it permits tracing widely varied surfaces at the same magnification for direct comparison of profiles. Thus

Continued on Page 42

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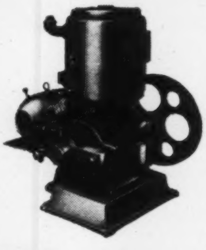

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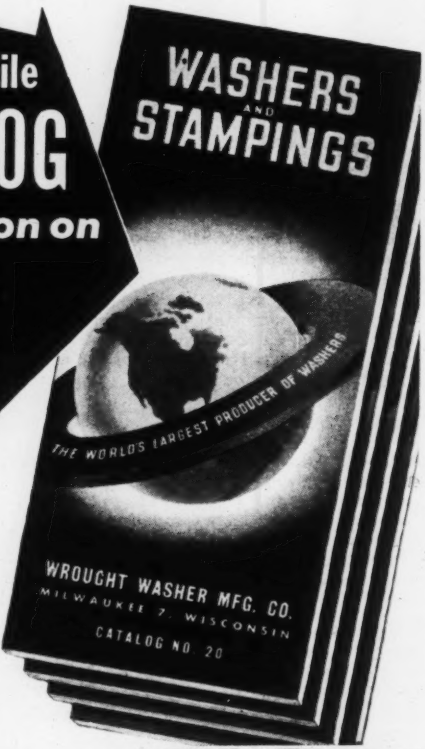

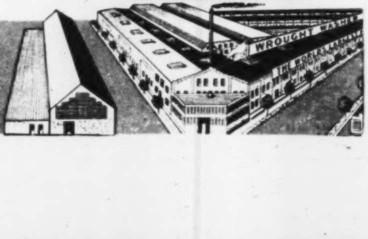

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this instrument opens new possibilities in production inspection, quality control, and in technical research and development—wherever accurate knowledge of the causes, effects and characteristics of surface irregularities will be of value. The equipment is ruggedly constructed to withstand shop use, and operation is quickly learned.

The Proficorder is designed particularly to show waviness, bows, steps and other surface irregularities spaced approximately $^1/_{32}''$ apart or farther, rather than the more closely spaced irregularities which make up surface roughness. Thus, in machining and grinding applications, the primary function of this instrument is to show irregularities caused by the machine or set-up used to produce the surface, rather than showing roughness caused by the cutting action of the tool or wheel. However, fine roughness irregularities can also be recorded in full detail.

A Proficorder includes (1) a Tracer with diamond tracing point; (2) a Pilotor with motor-driven slide for moving the Tracer; and (3) an Amplicorder unit, consisting of an amplifier, the chart recording mechanism and the control panel, assembled in a cabinet which is mounted on casters for easy portability. Various Tracers and Pilotors provide for profiling on flat or cylindrical surfaces, external or internal, and on remote portions of large surfaces such as machined base plates, rolls and cylinder bores. Length of trace is adjustable from $^1/_{32}''$ to a maximum of 9″ or more, depending on the Pilotor used.

Further information is given in an illustrated bulletin available on request from Physicists Research Co., 321 S. Main St., Ann Arbor, Mich.

Air-Cooled Gasoline Engines

Briggs & Stratton Corp., Milwaukee, Wis. announce three new models in their current line of 4-cycle, air-cooled, gasoline engines. Model "9" is rated at 2.16 to 3.1 h.p.; Model "14," 3.56 to 5.1 h.p.; and Model "23" at 6.5 to 8.25 h.p.. The ratings are based on standard I.C.E.I. procedures.

Among the many new features of these models is the Briggs & Stratton Magnematic Ignition System. A breaker box unit, externally mounted on the crankcase, incloses easily adjustable breaker points, condenser, manual stop switch and remote stop switch terminal. This system produces a high voltage at very low speeds and incorporates an automatic spark retard and advance, assuring quick, easy, pull-up starting—no spinning necessary.

Standard engines are available with plain or ball main bearings. Enclosed adjustable governor, operating in oil, provides improved speed regulation under all conditions. A new vacuum breather and spring loaded oil seals prevent oil leaks. A handy snap-on oil filler cap eliminates necessity for a wrench

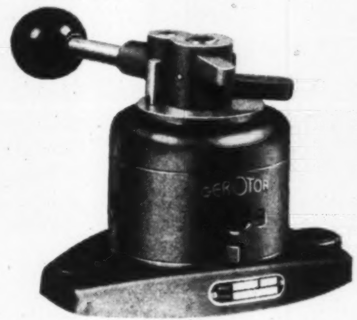
• Keep Informed

when adding or changing oil. A starter rope or a hand crank, or both, can be furnished.

It is claimed by the manufacturer that these and other features, make the new models especially adaptable for powering many different kinds of machines, tools and equipment used on farms, in industry and construction work, and by railroads. Detailed specification sheets and power curves are available by writing to the manufacturer.

Oil Pilot Valves

A new line of oil pilot valves is now offered by Gerotor May Corp., Baltimore 3, Md. Known as the Series 7000, they are used for remote control of oil pressure operated 4-Way hydraulic valves.



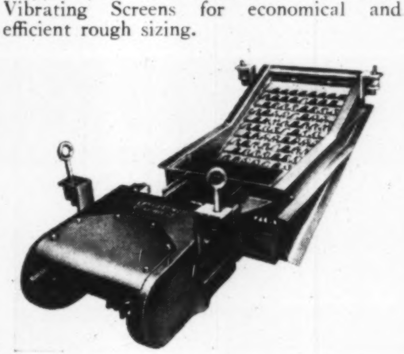
Operational Control is gained in Gerotor oil pilot valves by a fork lever design, which, when actuated by a moving part of the device being powered, permits the remote reversing of the main 4-Way valve. Both fork lever and fork and hand lever types are supplied. The latter permits manual interruption of the cylinder's forward or return stroke at any time.

Four standard mountings are available: pipe line, base, foot, and panel. Gerotor oil pilot valves may be had with all ports blocked in neutral, all ports open to exhaust in neutral, and cylinder ports open to exhaust and pressure port blocked in neutral.

Twenty-five models, including solenoid operation, are illustrated and described in catalog section 201. Copies may be had by writing Gerotor May Corp., Baltimore 3, Md., and mentioning this magazine.

Syntron Vibrating Screens

Syntron Co., 496 Lexington Ave., Homer City, Pa., now has available a new line of Vibrating Screens for economical and efficient rough sizing.



They are made up with stepped, punched plates having tapered elongated openings—the size of the latter depending upon material specifications.

Single or multiple deck screen plates as desired (see illustration).

The screen area is activated by the Syntron "Vibra-Flow" Vibrating Motor featuring variable control of material flow.

Continued on Page 44

Centralize
and SAVE!

THE Aldrich Central Hydraulic System illustrated above is installed in a textile belting plant, where it provides hydraulic pressure used in impregnating fabric belts with rubber and in laminating belt sections to produce continuous belting.

By means of the Aldrich-Groff "POWR-SAVR" Controllable Capacity Pump, all of the hydraulic pressure required—*but only that pressure actually needed*—is supplied. This pump automatically controls delivery—in almost direct proportion to demand.

And, by means of the Central System, all hydraulic pressure originates from a single, compact source—affording the least amount of machinery, less maintenance, and quick, easy accessibility. The Aldrich Central Hydraulic System is good engineering—simple, direct, efficient.

For whatever application of hydraulic pressure you may have, and to provide you with pumping equipment that specifically fits your individual requirements—Aldrich builds many types of reciprocating pumps, from the variable stroke "POWR-SAVR" through the constant stroke, constant speed, Inverted Triplex pumps—up to and including the Inverted Nonuplex of 2400 H.P.

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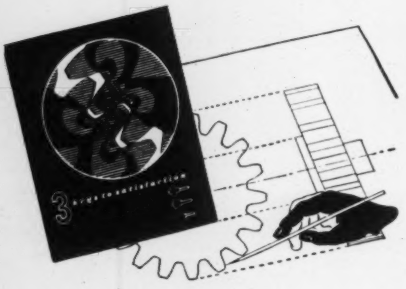

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MOLY

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This provides a two-purpose piece of equipment, a vibrating screen and a rheostat controlled vibratory feeder—for increasing the efficiency and capacity of crushers and fine grinders and prevent damage to belt conveyors by allowing the fines to cushion the lumps.

Additional data is available from the manufacturer.

Circular Form Tools Speed Bronze Labyrinth Seal Production

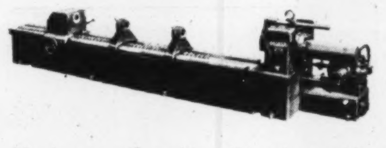
A new application of a standard type of circular form tool recently paid dividends in increased production at the Sunnyvale, California, plant of Westinghouse Electric Corp.

The plant's extensive steam turbine manufacture requires many grooved bronze labyrinth seals. The important function of these seals is to prevent steam from escaping along the various bearing and blade stages of the turbine spindle.

Since the labyrinth seals are bronze, they are extremely abrasive to any tool point. Whenever the point of one tool was worn or chipped, the whole group of tools had to be removed and new ones substituted. This pressure was both expensive and time-consuming. Consideration was given to the use of circular formtools which can readily be reground and used again. This method was promptly adopted and proved to be thoroughly satisfactory. The circular disks, which turn together and thus are automatically lined up, are easy to set. The radius of the disks provides a positive duplication of dimensions. When re-grinding makes it necessary to rotate the tools slightly to the new cutting position, it is a simple matter to re-set the arbor on the shaft.

The new method speeds production of the circular labyrinth seals by approximately 30 percent.

Oilgear 35 Ton Special Horizontal Assembling Press



Having an adjustable tail stock capable of resisting full tonnage makes this press, made by The Oilgear Company, 1307 W. Bruce Street, Milwaukee 4, Wis., adaptable for assembling a variety of propeller stub shafts in tubes. Daylight is adjustable from 30″ to 180″ in increments of 3″. Tail stock is moved on hardened and ground ways through a handwheel, pinion and stationary rack. Tail stock is locked to ways with screws and gibs. Locking pawl is lever operated. Two 4″ bore × 6″ wide split steadyrests with locking levers can be adjusted to any spacing and clamped to ways. Ram has auxiliary guide arm and rod. Hand lever control is spring centered. An Oilgear Type DH-

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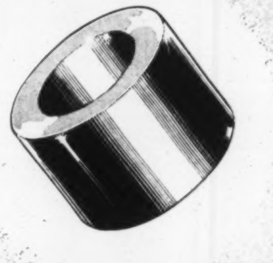

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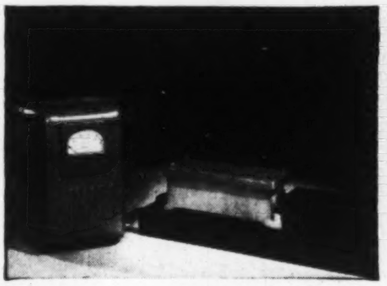
2017 Two-Way Variable Delivery Pump is direct connected to a 15 H.P. electric motor. Similar presses are used to assemble R.H. and L.H. rear axle tube assemblies to rear differential housings. General Specifications: Stroke 18". Maximum daylight 180". Floor to centerline of ram 37". Throat 11¾". Pressing speed variable up to 114"/min. Return speed variable up to 242"/min. Shipping weight 13,970 pounds.

Westinghouse Announces Magnetic Strain Gauge



The magnetic strain gauge, which provides a simple method of directly measuring small distortions in a static member resulting from a tensive or compressive load, is announced by Westinghouse Electric Corp.

It is particularly useful as a warning to the operator when a crane is in danger of upsetting due to overloading, or on other metal structures where variations in load may approach safe limits of the supporting member.

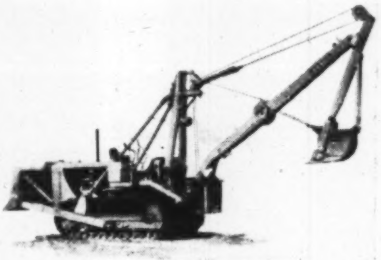
The unit consists of the strain gauge enclosed in a water-tight case (3½" × 8¼" × 3¼") and pilot bar sensitive to a force as small as 20 pounds which is rigidly mounted on the supporting member and a controller with indicating dial located wherever desired near the operator.

Operation is from a single phase, 110-volt, 60-cycle supply. Voltage and frequency variations should not exceed plus or minus 3 percent. Power required is 35 volt amperes.

Further information concerning this magnetic strain gauge may be obtained from the Westinghouse Electric Corp., Box 868, Pittsburgh 30, Pa.

Hyster Hystaway

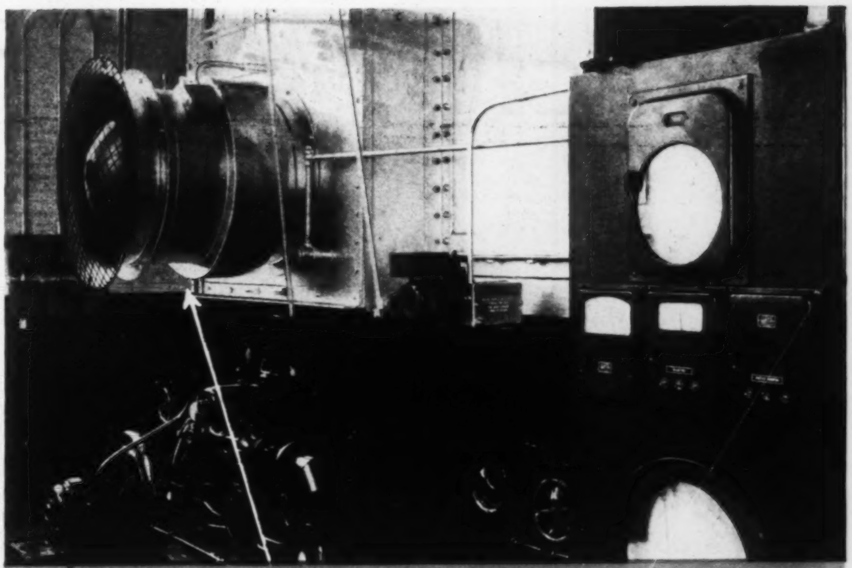
First shipments are now being made of a ½ cubic yard capacity Hoe Front, newly added to the dragline, clamshell, and crane features of the Hyster Hystaway, attachment for use with "Caterpillar" track-type tractors.



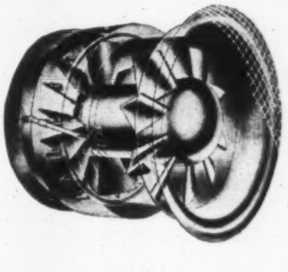
Installation of the Hoe Front on the D7 and D8 Hystaway can be accomplished without major alterations to existing machines. The Hoe dipper has a cutting width of 33 inches, and for narrow ditching requirements an optional dipper of 23 inch width may be substituted.

The Hoe with its fast swing and abundance of power has proved to be an exceptionally speedy excavator in all classes of digging.

Continued on Page 46



The Wing Blower is "working out to the fullest satisfaction of everyone"



Wing EMD Blower showing simple design and built-in volume control. Internal radial dampers are actuated by an external balanced lever. Can be adjusted manually or by combustion controls.

That comment "to the fullest satisfaction of everyone," quoted from a recent letter, is characteristic of Wing Blower installations. For these Axial Flow Blowers are *built* to give satisfactory performance . . . simple and rugged construction, compact design with built-in capacity regulating dampers, combining high efficiency with quiet performance. Installation costs, too, are low. Write for descriptive bulletin or specific details.

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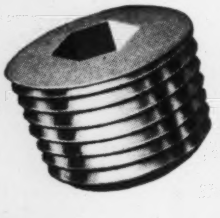
LEAKAGE!



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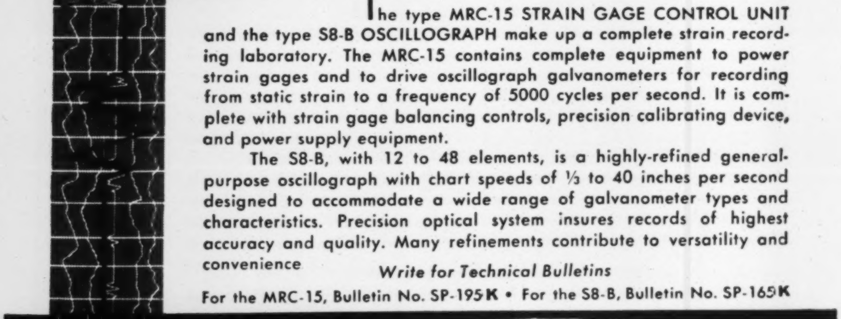

The type MRC-15 STRAIN GAGE CONTROL UNIT and the type S8-B OSCILLOGRAPH make up a complete strain recording laboratory. The MRC-15 contains complete equipment to power strain gages and to drive oscillograph galvanometers for recording from static strain to a frequency of 5000 cycles per second. It is complete with strain gage balancing controls, precision calibrating device, and power supply equipment.

The S8-B, with 12 to 48 elements, is a highly-refined general-purpose oscillograph with chart speeds of 1/3 to 40 inches per second designed to accommodate a wide range of galvanometer types and characteristics. Precision optical system insures records of highest accuracy and quality. Many refinements contribute to versatility and convenience

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For the MRC-15, Bulletin No. SP-195K • For the S8-B, Bulletin No. SP-165K

Hathaway
INSTRUMENT COMPANY
1315 SO. CLARKSON STREET • DENVER 10, COLORADO

• Keep Informed

Because the center of swing is beyond the crawlers, the Hoe can reach farther into the excavation than other conventional machines of comparable size.

Full tractor mobility, maneuverability and conversion characteristics, for which the Hystaway is noted, are completely retained with the new Hoe Front. Quick change-over from one front end attachment to another is easily accomplished. Utility use of the bulldozer is possible even with the Hystaway installed, and it takes only one hour to dismount the Hystaway to allow full production bulldozer use. The entire unit may be mounted on the tractor in about two hours, following the initial installation.

Now being used all over the world in a variety of construction jobs, the Hystaway will find even wider application through the addition of the Hoe Front.

New Bruning Whiteprinter Has Output of 105 Sq. Ft. per Minute

A new large volume Whiteprinter has just been announced by the Charles Bruning Co. for use in engineering and business offices with a large volume of duplicating work. This machine reproduces anything drawn, typed, written, or printed upon translucent mediums, at speeds up to 105 square feet per minute. Prints from post card size up to those 42" wide and any length are made on the same machine with equal ease.

This new Bruning Whiteprinter is called the Volumatic Model 93. It produces direct positive prints (black lines on white or tinted stocks) directly from the original drawing or document without intermediate steps. BW prints are exact copies of the original.

No special trainng is needed to operate the Volumatic. The operator simply feeds the material to be duplicated into the machine. The rest is completely automatic. BW prints are delivered in a few seconds—stacked, flat and dry, ready for immediate use.

The BW Process is odorless. The Volumatic can be operated anywhere in the plant or office without ventilating ducts. The finished BW prints can be safely filed with other types of prints without fear of bleaching.

The Bruning Volumatic Model 93 is the first large volume machine to provide a built-in constant voltage transformer as standard equipment. Only Bruning Whiteprinters offer this feature. This transformer compensates for fluctuations between 190 and 250 volts in the public power lines. It keeps the speed of the motors and the rated output of the lamp constant. This feature saves time, prevents print spoilage, assures longer lamp life, and uniform prints at all times.

A unique sheet separating device automatically returns the original to the operator, while sending the print on through the developing unit of the machine. The operator chooses between front and rear stacking of finished BW prints simply by moving a lever.

Another important feature provides uniform development of prints, regardless of speed setting. The exposed print is fed automatically between developer rolls which apply developer solution to both sides of the paper simultaneously—as in a wringer. The speed of development is automatically coordinated with the printing speed of the machine. This feature assures properly developed flat prints at all times.

The Volumatic is easy to install. It requires no plumbing connections, ventilating ducts, or darkroom. It is self-contained, and can be moved on its casters wherever needed. All parts are easily accessible, and servicing is simple.

Full information about the Volumatic Model 93 and the work it does is given in Bulletin No. A-1053 recently published by the Charles Bruning Co., 4754 W. Montrose Ave., Chicago 41, Ill. A copy will be mailed without obligation if you request it.

Detachable Roller Chain Now Available in All Sizes

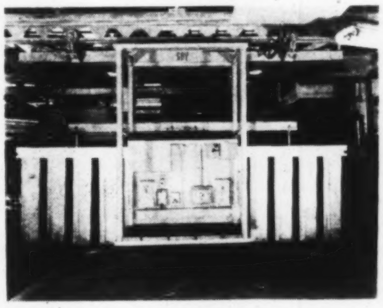
For the many engineers who have always preferred detachable roller chain over the riveted type, Atlas Chain & Mfg. Co. has just developed a new type of fastener that makes possible the use of detachable roller chain in all sizes below ³/₄″ pitch.

The answer is a new type of fastener essentially a retaining ring—that fits into a groove on the pin. Having no extending points, it cannot collide with other fasteners during chain drive operation.

The availability of detachable roller chain in smaller sizes will be welcomed by all those who have long preferred this type.

Hydraulic Cylinders Improve Ice Harvester Operation

There are three basic motions in an ice crane—(1) hoisting and lowering ice from freezing tank, (2) left and right cross travel trolley motion, and (3) forward and reverse bridge travel. These three motions are usually accomplished by three individual slip-ring or hoist type motors controlled by a two or three step electrical switch gear, operating through reduction gear train to one or more sets of trolley wheels.



For the forward and reverse bridge travel (3), this method produces little or no difficulty since the route is long, the speed high, and the rate fairly uniform.

For the other two motions, however, this control causes many operating difficulties, especially with semi-skilled and inadequately trained operators. Even the best of operators cannot entirely avoid the shock impact

Continued on Page 48

FLEXIBLE SHAFTS

Wherever power drives or remote control are required, you can depend upon us to produce the Flexible Shafts that will meet the exact specifications. We have years of experience in manufacturing flexible shafting for all types of industry. If we do not have what you require in stock, we can make shafts to your specifications. Our engineers will be glad to work out your problems without obligation.

MACHINERY ELECTRONICS AUTOMOTIVE AIRCRAFT

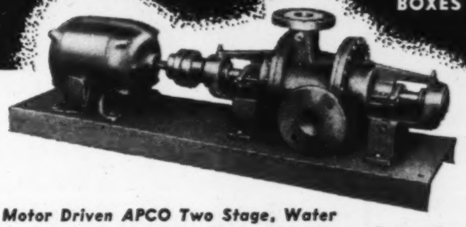
Many new uses for flexible shafts that carry power around any corner have been developed by our engineers . . . in machine shops, electronic, automotive, aircraft, in all industries where power drives or remote control are required. Write for Manual E.

CIRCLE

F. W. STEWART MFG. CORPORATION
4311-13 RAVENSWOOD AVE. CHICAGO 13, ILL.
WEST COAST BRANCH. 131 Venice Blvd.; Los Angeles 15, Cal.

FOR HANDLING HIGH TEMPERATURE AND HIGHLY VOLATILE LIQUIDS

NEW! WATER JACKETED APCO with EXTRA DEEP STUFFING BOXES



Motor Driven APCO Two Stage, Water Jacketed, Turbine-Type Pump with Flange Connections.

SINGLE AND TWO STAGE • 1750 R.P.M. • WIDE RANGE OF SIZES • FOR SCREW OR FLANGE CONNECTIONS

Write for BULLETIN 111-WJ

These notable pumps are made available "by request" of many of our engineer friends. Water jacketed APCO pumps were developed specifically for the efficient handling of high temperature and highly volatile liquids. They are designed to compensate for expansion and contraction due to heat. Because Apco's multi-vaned impeller handles vapor or air along with the liquid there can be no vapor lock within the pump. The cool liquid in the water jacket reduces the temperature of any liquid leakage through the extra deep stuffing boxes — thus flashing or vaporizing of the leakage is prevented. May be made of any machinable metal for handling corrosives. Requires but small amount of such special metal — with resultant economy. We invite your consideration of the many features of these fine pumps.

AURORA CENTRIFUGAL PUMPS

A complete line, notable for streamline coordination between impellers and shells, including Single and Two Stage Horizontally Split Case, Side Suction, Vertical, Non Clog, Sump, Mixed Flow, Special Design, etc.

DISTRIBUTORS IN PRINCIPAL CITIES

AURORA Always PUMPS

AURORA PUMP COMPANY
96 Loucks Street, AURORA, ILLINOIS

HOW YOU SAVE,

Getting Drier Compressed Air

● Direct saving in the cost of cooling water saves the price of the Niagara Aero After Cooler (for compressed air or gas) in less than two years.

Extra, for no cost, the drier air gives you a better operation and lower costs in the use of all air-operated tools and machines, paint spraying, sand blasting or moisture-free air cleaning. Water saving also means less expense for piping, pumping, water treatment and water disposal, or you get the use of water elsewhere in your plant where it may be badly needed.

Niagara Aero After Cooler assures all these benefits because it cools compressed air or gas below the temperature of the surrounding atmosphere; there can be no further condensation in your air lines. It condenses the moisture by passing the air thru a coil on the surface of which water is evaporated, transferring the heat to the atmosphere. It is installed outdoors, protected from freezing in winter by the Niagara Balanced Wet Bulb Control.

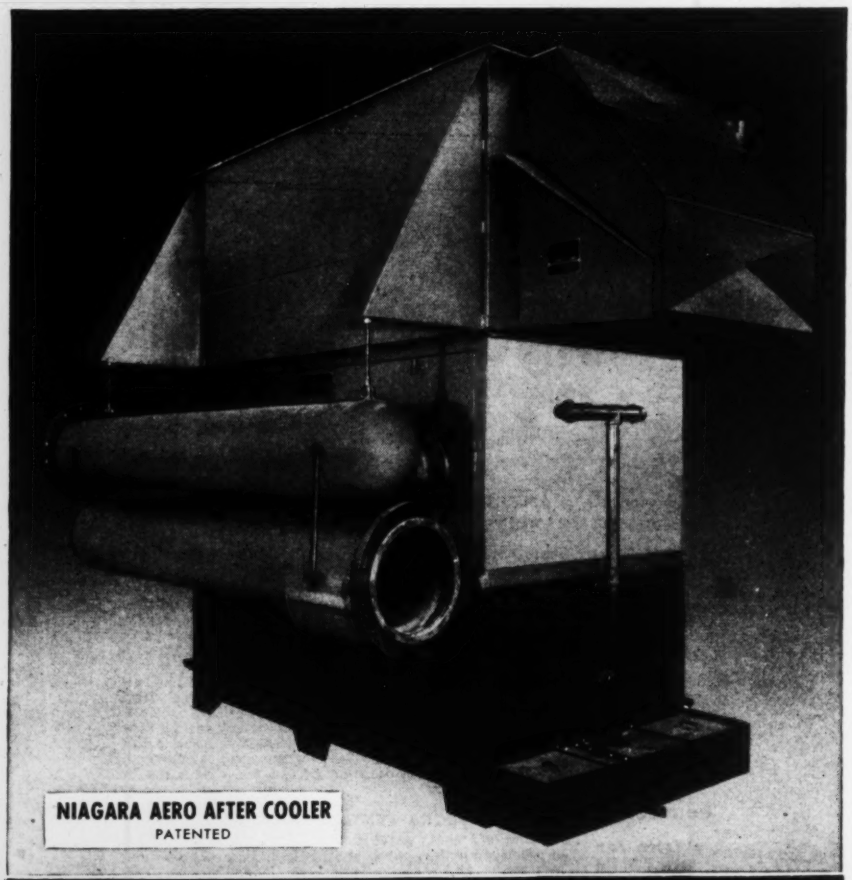
Write for complete information; ask for Bulletin No. 98

NIAGARA BLOWER COMPANY

Over 35 Years of Service in Industrial Air Engineering

Dept. ME, 405 Lexington Ave., New York 17, N. Y.

District Engineers in Principal Cities



NIAGARA AERO AFTER COOLER
PATENTED

INDUSTRIAL COOLING • HEATING • DRYING
NIAGARA
HUMIDIFYING • AIR ENGINEERING EQUIPMENT

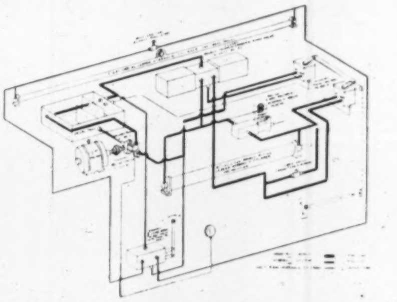
• Keep Informed

loads each time that the hoist motion begins, each time the hoisting speed is changed, and each time the hoist is stopped—a total of 13 to 20 times per trip. Nor can the most highly trained operator avoid the sudden starts, changes of speed, and inaccurate positioning of the cross travel when this type of control is used.

The Gay Engineering Co. has produced and put on the market a crane which overcomes those difficulties and provides smooth starting and stopping, infinitely variable speeds, shockless operation, and perfect control by even an inexperienced operator. This is accomplished by a hydraulic system incorporating Ledeen Heavy Duty Cylinders to provide the hoisting and cross travel motions.

In this hydraulic control there are no steps, switches, make and brake electrical contactors, or other highly technical and mysterious devices requiring a long educational period for operators. Further, this method calls for practically no maintenance.

The assembly consists of a constant volume hydraulic pump direct coupled to a standard constant speed induction motor which produces the necessary fluid pressure up to 1,000 pounds per square inch to actuate two cylinders.



The hoisting cylinder is a standard Ledeen Heavy Duty Hydraulic Cylinder, double acting, 8" in diameter with 42" stroke.

The cross travel cylinder is specially designed by Gay, and built by Ledeen. It consists of two single acting pistons in a long tube (3" diameter by 14 feet long), connected by a rack which actuates a pinion at the center and just outside of the tube, giving a stroke of 78". This pinion actuates a grooved drum over which is wrapped a wire rope, both ends of which are fastened to the crane bridge and through which the energy from the fluid pump transmits reciprocating motion to the trolley.

The beginning of motion in either direction, the acceleration in infinite degrees to full speed, the deceleration infinitely selective to full stop, and the location at rest at any point are under complete and constant control of the crane operator by the simple movement of a single lever to the left or right.

13,000 lbs. of ice are hoisted from 0 to 16 feet per minute, and lowered from 0 to 50 feet per minute; trolley speeds are controlled back and forth from 0 to 120 feet per minute, and dumping speeds are controlled from fast to slow as required, all completely free of shock and impact loads.

High-Intensity, Slow-Speed Stroboscope

General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass., has just introduced the Strobolume, a new development. It is a high-intensity, short-flash stroboscope designed primarily for stroboscopic observations on machinery operating at relatively low speeds, such as textile looms, printing presses, fuel injection systems, and heavy machinery in general. Low-speed stroboscopic observations are not very satisfactory with low-intensity light sources because of the inevitable flicker, which makes it difficult for the eye to register an impression. With the high-power Strobolume, even a single, isolated flash produces a definite stationary image of the moving object on the retina of the eye, so that the stroboscopic method of analysis can be extended to cover low-speed mechanisms satisfactorily.

The Strobolume is designed to be flashed from an external contactor, and hence is particularly useful where the motion to be examined is related to the angular position of a shaft, such as a crankshaft, camshaft, or countershaft, on one end of which a contactor is held or clamped. A push-button is provided for tripping single flashes manually. The lamp can also be flashed from a special, slow-speed Strobotac.

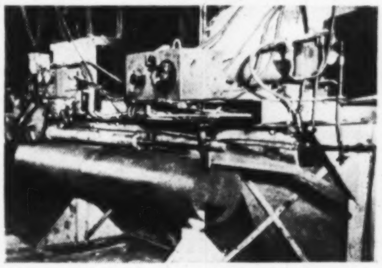
Because of the high-intensity and short duration (10 micro-seconds) of the flash, the Strobolume can also be used as the light source in high-speed photography where the motion of the subject is too fast to be stopped by commercial "speedlights."

The Strobolume will operate continuously at speeds up to about 45 flashes per minute. Operation for increasingly shorter periods is possible up to 1200 per minute. When maximum safe operating time is reached at any speed, a circuit breaker opens to turn off the power supply. Typical safe operating times are 30 seconds at 600 flashes per minute and 15 seconds at 1200 per minute.

Compact and portable, the complete stroboscope is housed in a convenient metal case with handle. Over-all dimensions are 13 × 7-$^1/_2$ × 11 inches, and net weight is 18-$^1/_2$ pounds.

The lamp assembly is connected to the power supply through a 10-foot cable and is removable from the case, so that it can be placed or clamped in the optimum position for viewing.

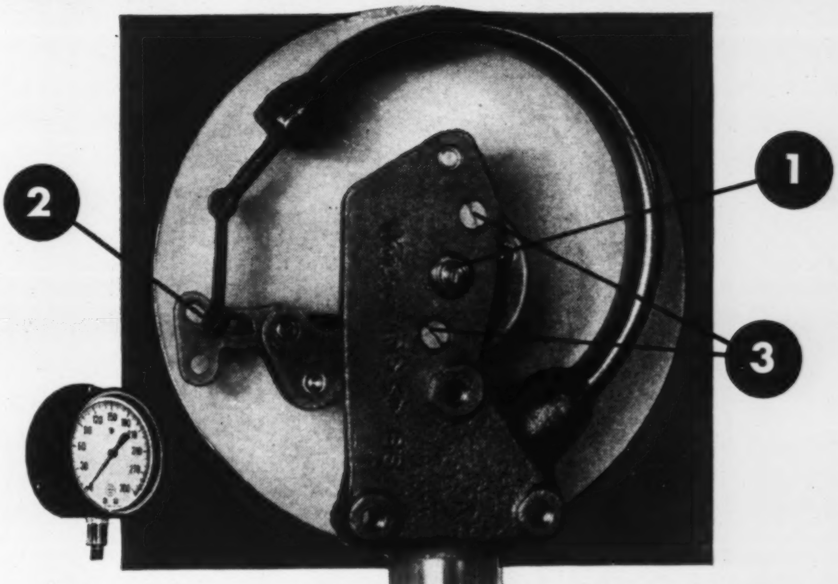
Mill for Welding Water Tanks of Varying Diameter



A semi-continuous seam welding machine was designed and built by a West-Coast manufacturer, Southern Heater Co., Compton, Calif., of hot water tanks for welding tanks of various diameters. Regulation of

Continued on Page 51

EASIEST GAGE TO CALIBRATE

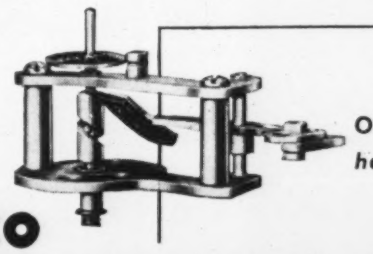


So says the Instrument Engineer

Here's Why: The external pointer set (1) is handy and very useful. In no other gage can the pointer be set without removing the glass and ring. Often a HELICOID gage can be made accurate simply by resetting the pointer.

If recalibration is necessary, the complete gage system is removed from the case. But there is no need to remove the pointer or dial. All adjustments are conveniently at the rear. For pointer travel, the link screw (2) is moved inward or outward in the cam slot. For scale linearity the movement is rotated by loosening screws (3). All this can be done quickly with a Helicoid gage. When recalibrating other gages, the pointer and dial must be removed frequently until calibration is attained. This takes more time and costs money.

The HELICOID gage is the easiest to calibrate and the easiest to keep in calibration.

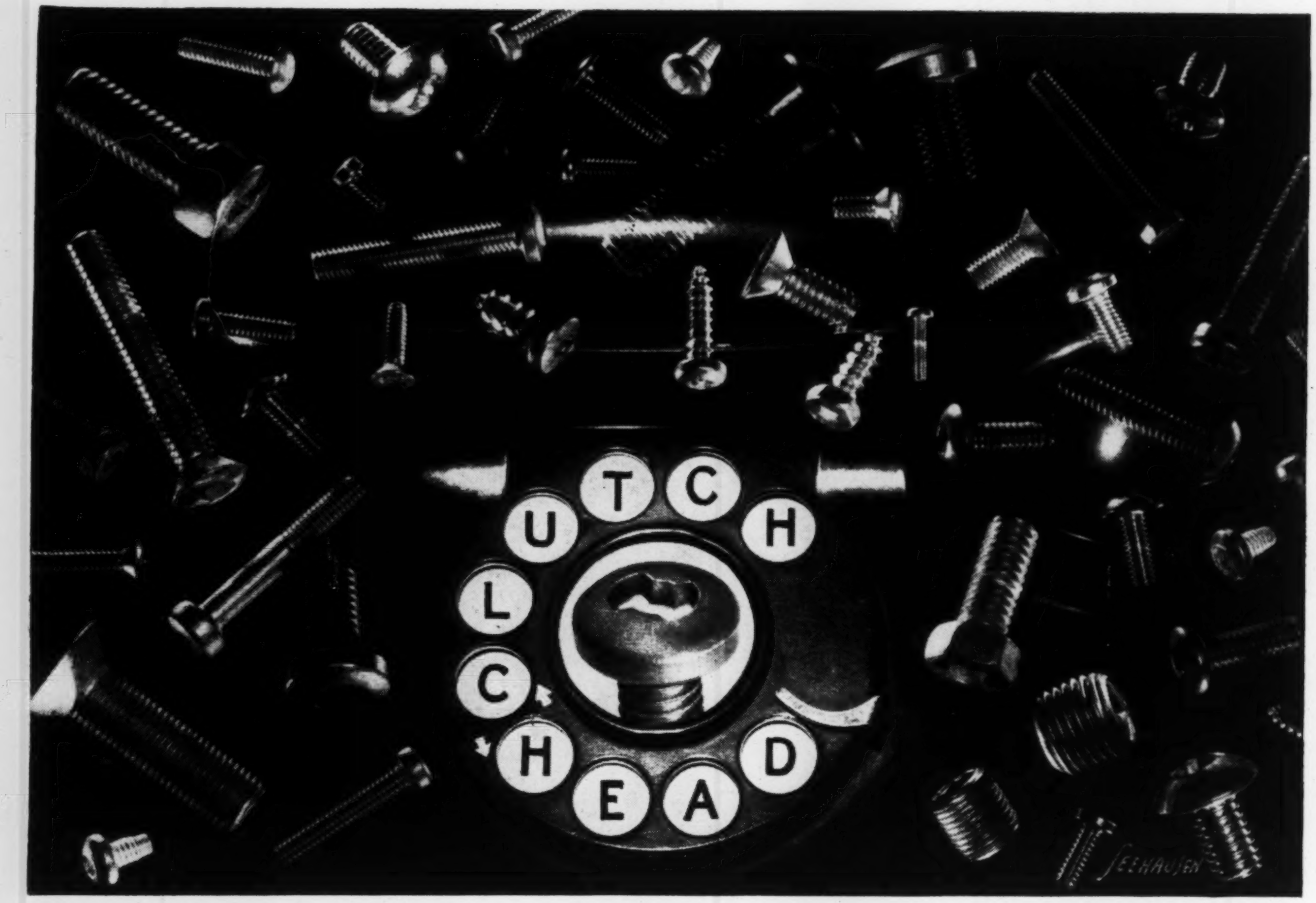


Only Helicoid Pressure Gages have the Helicoid Movement

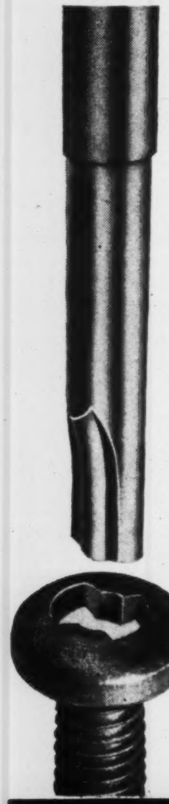
ACCO

HELICOID GAGE DIVISION
AMERICAN CHAIN & CABLE
Bridgeport 2, Connecticut

TRADE MARK



TYPE "A" ASSEMBLY BIT



COMMON SCREWDRIVER

On Call... ALL STANDARD **CLUTCH HEADS**

On Short Order... "SPECIALS" TO SUIT

Plant expansion, with greatly increased production facilities, has freed us from the bug-a-boo of the back-log.

More than that, it has resulted in the establishment of "banks" at the factories. Thus CLUTCH HEAD Screws, in virtually all standard sizes and types, may be called for with assurance of fast deliveries.

Likewise, with these extended facilities, you can rely on speedy action going behind your requirements for "Specials" to meet your specifications.

As always, CLUTCH HEAD is truly "*On Call*" for the delivery of safety and savings with features that are unequalled by any other screw on the market today.

Start your investigation of America's Most Modern Screw by sending for assortment of screws, sample Type "A" Bit and illustrated brochure

Only in CLUTCH HEAD *do you get the dual safety of automatic dead-center entry and non-tapered driving for zero in skid damage . . . plus easier driving with freedom from fatiguing end pressure to buck "ride-out." Only* CLUTCH HEAD *has the Lock-On to hurdle "fumble spots." Only* CLUTCH HEAD *has a*

CLUTCH HEAD - SCREWS -

Type "A" Bit rugged enough to drive 214,000 screws non-stop . . . and that can be repeatedly reconditioned on-the-spot in 60 seconds. And CLUTCH HEAD *alone simplifies field service with a recess that is basically designed for operation with a common screwdriver.*

UNITED SCREW AND BOLT CORPORATION

CLEVELAND 2 CHICAGO 8 NEW YORK 7

the welding current and the air pressure are the only adjustments necessary for welding tanks of different size. The longitudinal seam is made by the Unionmelt welding process, a method of welding electrically beneath a granulated welding composition which fuses in the welding zone and submerges the weld. The welds have complete penetration and are made without spatter. The fused composition detaches itself and reveals the smooth clean weld which does not require chipping or peening.

An operator forms the tank shells on pyramid rolls and feeds the cylindrical shells into the welding mill. A pneumatic ram forces each section against the preceding one and a chain drive moves the shells at welding speed beneath the welding head. A water-cooled copper shoe under the welding zone backs up the completely penetrated welds. The shells are fed through the mill on the lower flanges of an I-beam type support. Thus, shells from 8 to 48 in. diameter can be handled by the same fixture. After welding, the shells are taken by conveyor to the next station where the heads, bottoms and fittings are added.

With this machine, small lots of various diameters can be welded without shutting down the machine to adjust for each size of tank. The minimum diameter is determined by the size of the I-beam. Shells from 14 gauge to $^{3}/_{16}$ in. thick can be welded in any succession. The machine is set to weld at 48 in. per minute and currents range from 400 to 550 amp.

New Low-Cost Thy-Mo-Trol Drive

A new low-cost Thy-mo-trol drive, known as the Type H1, has been announced as available from stock by General Electric's Control Division. Furnished in ratings through $^{1}/_{2}$ hp, the new drive utilizes a simplified half-wave circuit to provide d-c flexibility from a-c power. It is specially designed to provide, by the turn of a knob at a single control station, smooth stepless speed control on small lathes, grinders, drill presses, conveyors, pumps, packaging equipment, and paint and varnish mixers.

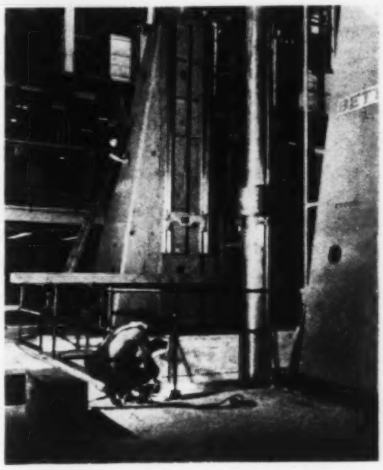
The drive operates from 220-volt, 60-cycle a-c (for other voltages a suitable anode transformer is available). It has a 20-to-1 speed range from 1725 to 86 rpm and operates efficiently in ambient temperatures from 50 to 104 F. It is furnished in either the nonreversing or the reversing type, the latter being equipped with a separate magnetic reversing switch.

Designed for constant-torque loads, under normal conditions the new drive has excellent speed regulation from no load to full load. The speed may be preset, or may be varied during operation and under load. Dynamic braking permits quick stopping. With normal industrial voltage fluctuation the drive will operate satisfactorily, although it does not compensate for changes in line voltage. Maximum tube life is obtained when the voltage fluctuates no more than five per cent.

The electronic panel is mounted in a compact, ventilated NEMA Type 1 enclosure. The equipment is easy to wire since the terminals are located at the front of the panel and separated from the tubes by a protective cover. The complete drive is easily installed, either separately or directly on the machine, and requires little maintenance.

Additional information regarding the new Type H1 drive is contained in bulletin GEA-5179, which is available from the General Electric Co., Schenectady 5, N.Y.

Heavy Machinery Being Installed in G-E's New Turbine Building

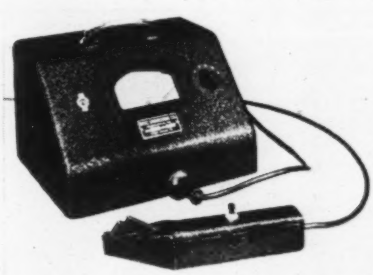


As General Electric's new turbine building at Schenectady, N. Y., nears completion, heavy production machinery is moved in as fast as possible. Here two workers install a vertical bar machine in one of nine quarter-mile long machinery bays.

The new plant, largest of its kind in the world, will be capable of turning out finished turbine-generator sets ranging from 20,000 to 200,000 kw. Costing $30,000,000, the plant covers 20 acres of ground. Full scale production is expected to be underway in 1950.

New Electronic Comparator

A new, electronic comparator, which provides accurate surface control of machined parts as quickly and easily as routine dimensional checking, has been announced by the Merz Engineering Co., Indianapolis, Ind.



This new Merz unit, the Merz Pico Surface Comparator, checks surfaces electronically against an approved sample, and assures instant, accurate meter readings. Because

Continued on Page 52

It doesn't pay to PINCH PENNIES

on

CUTTING FLUIDS

IN selecting cutting fluids, performance — not price — is the important factor. Savings pinched out in purchasing are often thrown out in the scrap pile. A large Milwaukee screw products company learned this in machining Type 304 stainless steel tube stock on a single spindle Cleveland Automatic, using Tantung high speed tools. Of several cutting fluids tried for this operation, D. A. Stuart's ThredKut 99 with paraffin oil was found to be the only one which would enable the shop to produce this job at a profit.

On the forming operation, ThredKut 99 permitted production of 500 to 600 pieces per grind, as compared to only 100 to 135 with other oils; on drilling 300 to 400 pieces with ThredKut 99, only 75 to 100 with other oils; and 22 pieces per hour average with ThredKut, only 8 with other oils!

You can't get around performance records like these. Cutting oil at any reasonable price is a sound investment when it pays off in longer tool life, increased production and desired finish. You can buy cheaper oils and more expensive oils, but in this case as in most others, it is *wise economy* to buy the Stuart oil best suited for the job. Write for booklet, *Cutting Fluids for Better Machining.*

STUART *service goes with every barrel*

D. A. Stuart Oil CO.

2741 South Troy Street, Chicago 23, Ill.

To Save Even One Life-
Who'd Count The Cost?

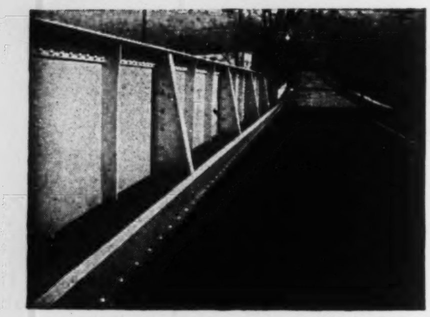
YOU CAN DO BOTH WITH

IRVING DECKING

The Safest as well as the most Economical

BRIDGE FLOORING

To learn How and Why-write for catalog



IRVING DECKING on Rural Fixed Span

IRVING SUBWAY GRATING CO., INC.
ESTABLISHED 1902
Home Office and Plant: 5810 27th Street
LONG ISLAND CITY 1, NEW YORK
Western Division: Foot of Park Ave.
EMERYVILLE 8, CALIFORNIA

it is simple, compact and portable, it can be used handily anywhere on the production line, without special accessory equipment or specially skilled operators. It is entirely self-contained in an aluminum case, complete with carrying handle and storage drawer. Overall dimensions are 11″ × 9″ × 7″. The unit weighs approximately 15 pounds, and operates from any 110-volt, 60-cycle outlet.

The Merz Pico Comparator consists of meter, exploring head and adapter. Readings are taken in 5 seconds, simply by pressing the head against the surface being checked, touching the actuating button and comparing the meter reading against the Master reading. One of the unit's many desirable features is its knife-edge meter pointer, which reads only one point on the scale, thus eliminating calculations or averaging.

Another important feature of the Merz Pico is the area of exploration, which is some 500,000 times greater than with tracer methods—and there is no diamond to scratch the work.

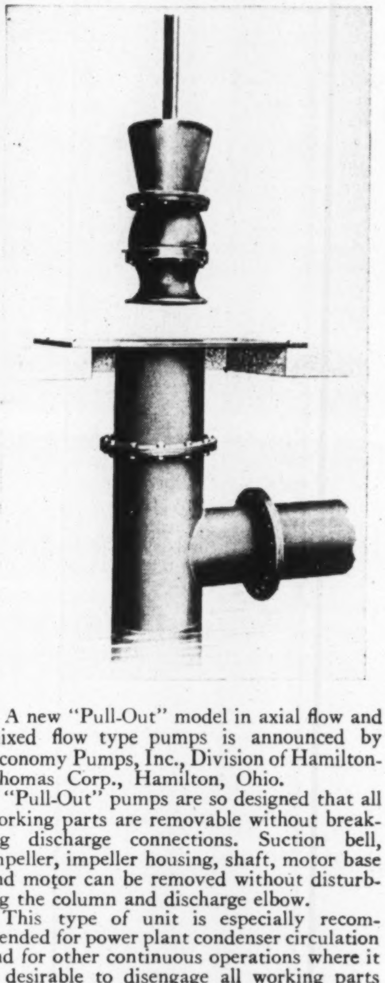
Because the new Pico Comparator is low in initial cost, and since continued savings result from its use, its economy, plus its convenience, make it equally well suited to small shops and large-scale manufacturing plants.

Complete information on the Merz Pico Surface Comparator is available from the manufacturer, upon request.

Self-Priming Packaged Pumping Unit

A new self-priming pumping unit, designed for use where electric power or belting facilities are not available, has just been announced by Gardner-Denver Co., Quincy, Ill. Known as the Type LDA, this packaged unit consists of a self-priming centrifugal pump close-coupled to an air-cooled gasoline engine. A double discharge volute is said to assure efficient priming, and a mechanical seal eliminates the conventional stuffing box and packing gland. Pump is equipped with an open type impeller for dewatering service where some small solids may be encountered. The manufacturer recommends the LDA Packaged Unit for any water application requiring capacities from 75 to 250 g.p.m. at a 110-foot head and the unit is said to be especially useful for flood protection during power failures.

New "Pull-Out" Axial Flow Pumps



A new "Pull-Out" model in axial flow and mixed flow type pumps is announced by Economy Pumps, Inc., Division of Hamilton-Thomas Corp., Hamilton, Ohio.

"Pull-Out" pumps are so designed that all working parts are removable without breaking discharge connections. Suction bell, impeller, impeller housing, shaft, motor base and motor can be removed without disturbing the column and discharge elbow.

This type of unit is especially recommended for power plant condenser circulation and for other continuous operations where it is desirable to disengage all working parts for periodic inspection without breaking pipe or mounting connections. It is particularly advantageous when the discharge elbow is below floor level, or when the pit in which the pump is installed is not easily drained.

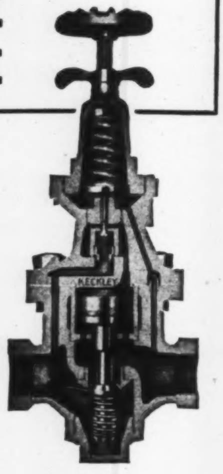
"Pull-Out" pumps are supplied in either cast or welded construction, and of alloy materials if specified.

This pump construction is available in pump sizes up to and including a capacity of 100,000 g.p.m.

World's Largest Plate Mill Plans $1,000,000 Conversion to G-E Electric Drive

The General Electric Co. will supply more than a million dollars worth of equipment to convert to electric drive the "World's Largest Plate Mill" located at Lukens Steel Co., Coatesville, Pa., it was announced recently.

DEPENDABLE SERVICE



Why have *KECKLEY REGULATORS* never disappointed industry no matter how rigid the demands? Because of the outstanding advantages which provide maximum service with minimum repairs:

Simplicity in design and precision regulation.

Stainless Steel construction of parts subject to most wear.

Stainless Steel springs for long, trouble-free operation.

Easily removed Stainless Steel "Unit Pilot Valve." Piston above flow, free from dirt and sediment, rides in easily replaced cylinder liner.

These are but a few of the reasons why *KECKLEY PRECISION PRESSURE REGULATORS* are so popular and have attained such a high degree of perfection . . . why repeat orders pour in each month.

Write for Descriptive Bulletin No. 51

• **Temperature Regulators** • **Pump Regulators** • **Steam Traps** • **Water Gauges** • **Gauge Cocks** • **Strainers**

1914—Thirty-Fifth Anniversary—1949

O. C. KECKLEY COMPANY
400 W. MADISON STREET
CHICAGO 6, ILLINOIS

• Keep Informed

The new drive will replace the 15,000-hp twin tandem cross compound steam engine now used on the 206-in., 4-high mill. Installed during the first World War, the giant mill can roll ingots up to 55 tons into the widest or thickest plates available anywhere.

The reversing motor to be supplied by G. E. will be a twin drive, with two 4000-hp, 30/75-rpm, 600-volt reversing motors; one direct connected to the top work roll and the other to the bottom work roll of the mill. The complete drive will have a continuous torque rating of 1,400,000 lb-ft and a maximum torque rating of 3,850,000 lb-ft. It is the second largest steel mill drive, in torque rating, that G. E. has ever built and, it is believed, the largest twin motor drive ever built.

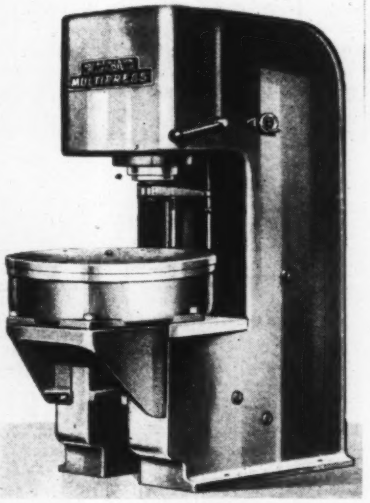
Power will be supplied to the reversing drive from a flywheel set consisting of four 1750-kw, 514-rpm, 600-volt generators, a 7000-hp, 13,200-volt, 3-phase, 60-cycle, wound rotor induction motor, and a 200,000-hp-seconds steel plate flywheel. The generators will have cross-connected series fields for load division, and all four will be paralleled on one bus to which both reversing motors are connected.

The control equipment supplied by G. E. will include amplidyne machines for control of generator and motor field strength, voltage maintenance, load limitation, load balance between top and bottom roll motors, and control of overshoot in speed after rapid reversal.

Other G-E equipment in the million dollar conversion includes a 13,200-volt switchgear unit for the plate mill motor room and a 750-kva unit substation for 440-volt a-c supply.

Denison Announces New High-Production 25-Ton Oil-Hydraulic Press

Fast action with high-tonnage pressures under accurate, regulative control are announced operational advantages of the new 25-ton Multipress oil-hydraulic press of The Denison Engineering Co., 1171 Dublin Road, Columbus, Ohio. Speed and control features in this floor model are said to be available for the first time in a press of this tonnage. Its precision adjustments for multiple ram actions give unusual flexibility for applications in many varied industries.



The 25-ton Multipress extends the range of standardized, self-contained oil-hydraulic presses in this line beyond the widely used

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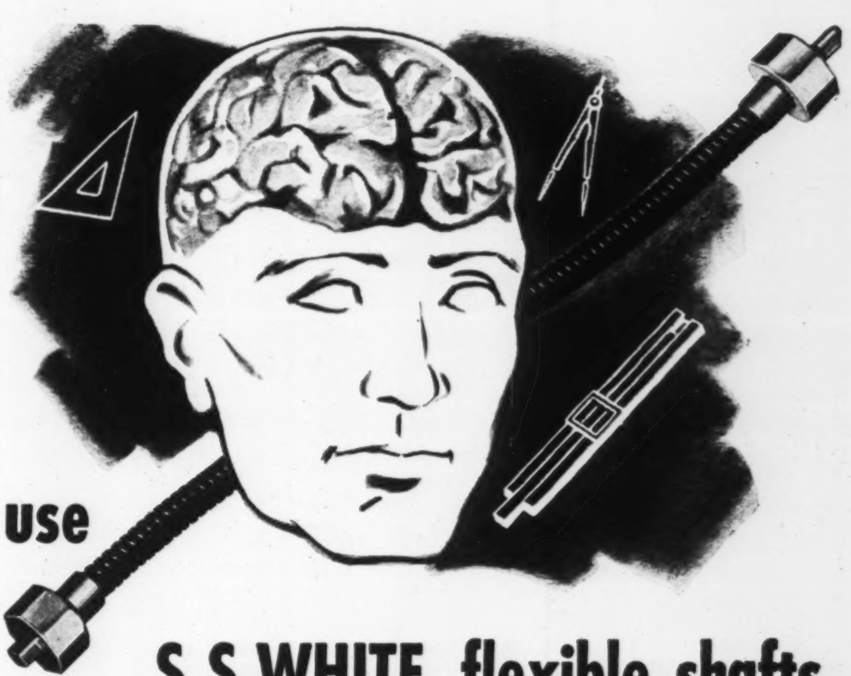

use

S.S.WHITE flexible shafts and S.S.WHITE *brains*, too!

For over 70 years these brains have been thinking about flexible shafts. They have been studying and planning how to make them better, smoother running, longer lasting. They have worked out a wide range of successful applications. They have, in fact, accumulated a vast knowledge of flexible shafts and experience as to what they can do and can't do.

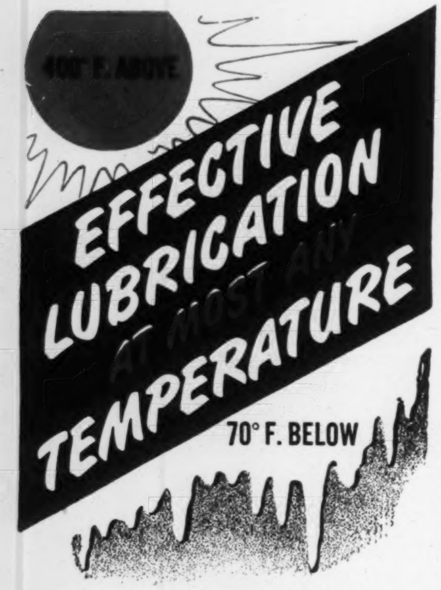
The point is—these brains are ready to work for you on any problem dealing with the application of flexible shafts for power drives or remote control. They can save you time and trouble because, in all possibility, they already have the answer to your problem. They may help you reach a more satisfactory answer, because the application of flexible shafts to all kinds of requirements and conditions is their special business.

S.S.White MAKES IT RIGHT

WRITE FOR THIS FLEXIBLE SHAFT HANDBOOK

It contains 260 pages of facts and engineering data about how to select and apply flexible shafts. A copy sent free if you ask for it on your business letterhead and mention your position.

S.S.WHITE INDUSTRIAL DIVISION
THE S. S. WHITE DENTAL MFG. CO. DEPT. L, 10 EAST 40th ST., NEW YORK 16, N. Y.
FLEXIBLE SHAFTS AND ACCESSORIES
MOLDED PLASTICS PRODUCTS—MOLDED RESISTORS
One of America's AAAA Industrial Enterprises


400° F. ABOVE
EFFECTIVE LUBRICATION AT MOST ANY TEMPERATURE
70° F. BELOW

The fact that LUBRIPLATE Lubricants are able to meet extreme temperature conditions, demonstrates the ability of these products to cope with the wide variations often found in everyday industry. Besides this feature LUBRIPLATE Lubricants possess attributes not found in conventional lubricants. Write for literature.

LUBRIPLATE

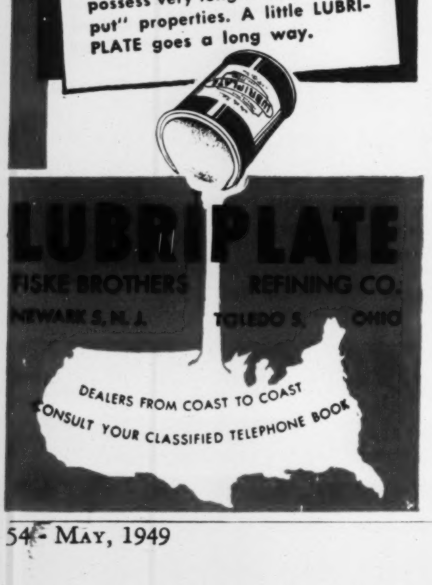
Lubricants definitely reduce friction and wear to a minimum. They lower power costs and prolong the life of equipment to an infinitely greater degree. LUBRIPLATE arrests progressive wear.

LUBRIPLATE

Lubricants protect machine parts against the destructive action of rust and corrosion. This feature alone puts LUBRIPLATE far out in front of conventional lubricants.

LUBRIPLATE

Lubricants are extremely economical for reason that they possess very long life and "stay-put" properties. A little LUBRIPLATE goes a long way.


LUBRIPLATE
FISKE BROTHERS REFINING CO.
NEWARK 5, N. J.
TOLEDO 5, OHIO
DEALERS FROM COAST TO COAST
CONSULT YOUR CLASSIFIED TELEPHONE BOOK

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bench-size 4, 6, 8 and 10-ton capacity used. It has a 15″ stroke, 25″ daylight opening, and a 12″ throat depth, all of which provide more die space in keeping with their higher tonnage capacities.

Approach of the ram to work is variable and can be preset at any speed desired up to 530 inches per minute, to meet exacting work requirements. Other operational factors that can also be preset include: ram stroke length, pressing speed and ram pressure. Uniform pressure application for every work cycle of the ram is obtained regardless of variations in dimensions of parts being processed.

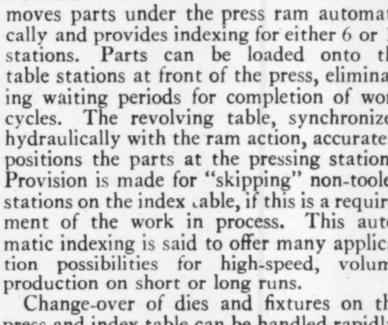
It is pointed out by the manufacturer that the adjustable characteristics of this high-tonnage, high-speed oil-hydraulic press permit unskilled operators to turn out production quality parts at full speed. Controlled uniformity of finished pieces results in fewer rejects and lower inspections costs. The press may be equipped with a choice of controls including dual hand lever, single lever, foot pedal or electric pushbutton types. It can also be operated with automatic valve controls for single cycling, continuous cycling, or vibratory repeat strokes. Automatic ram cycling also may be used in conjunction with variable speed approach, adjustable pressures, and interlocking hydraulic accessories. Added advantages include inching control of ram for quickly locating dies and tooling during set-up periods.

As a further extension of the automatic features of the new 25-ton unit, a large 33″ diameter hydraulic index table, may be installed. The Denison table accessory moves parts under the press ram automatically and provides indexing for either 6 or 12 stations. Parts can be loaded onto the table stations at front of the press, eliminating waiting periods for completion of work cycles. The revolving table, synchronized hydraulically with the ram action, accurately positions the parts at the pressing stations. Provision is made for "skipping" non-tooled stations on the index table, if this is a requirement of the work in process. This automatic indexing is said to offer many application possibilities for high-speed, volume production on short or long runs.

Change-over of dies and fixtures on the press and index table can be handled rapidly. The tooling ease of this new 25-ton Multipress and its companion model oil-hydraulic presses is reported to reduce press downtime to a negligible production cost factor.

Clark Fork Truck "Saves Day" for A.T.A. "Roadeo"

When huge highway trailers, qualified for the finals of the A. T. A. "Roadeo" competition in Washington, D. C., proved too large to pass under the entrances of the National Guard Armory, an SOS call to the Clark Equipment Company's Washington representative brought a speedy solution of the dilemma.



A Clark "Utilitruc" of 7000-lb. capacity was borrowed from Fallsway Spring & Equipment Co. of Baltimore. The trailers

SMALL PLANTS
are among our best customers

With the largest and most completely equipped organization in the well water developing field, Layne has always provided excellent service for even the smallest plants. In no case have they had to pay a penalty for Layne's world-wide experience and outstanding success. As a matter of fact, Layne Well Water Systems actually cost less when the advantage of unquestionable high quality, proven efficiency and extra long life are considered.

Small plants receive the same professional engineering, skillful workmanship and high quality equipment as is always provided for the largest industries. The only difference is in the size and capacity of the units installed. Several thousand small plants already have their own Layne Well Water Systems. All are highly pleased with their sound investments; the economy of operation cost and the complete dependability of the units at all times.

Small plants of all kinds;--mills, factories, theaters, food processors, packers, railroads, ice plants etc. are invited to make inquiries and to obtain catalogs about Layne's complete service which includes surveys, water strata, explorations, well drilling, pump installations etc. for a complete, thoroughly tested and in operation well water system. No obligation. Address LAYNE & BOWLER, INC., General Offices, Memphis 8, Tenn.

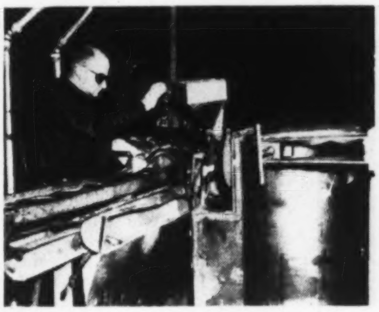
LAYNE
WELL WATER SYSTEMS

AFFILIATED COMPANIES: Layne-Arkansas Co., Stuttgart, Ark. ★ Layne-Atlantic Co., Norfolk, Va. ★ Layne-Central Co., Memphis, Tenn. ★ Layne-Northern Co., Mishawaka, Ind. ★ Layne-Louisiana Co., Lake Charles, La. ★ Louisiana Well Co., Monroe, La. ★ Layne-New York Co., New York City ★ Layne-Northwest Co., Milwaukee, Wis. ★ Layne-Ohio Co., Columbus, Ohio ★ Layne-Pacific, Inc., Seattle, Wash. ★ Layne-Texas Co., Houston, Texas ★ Layne-Western Co., Kansas City, Mo. ★ Layne-Minnesota Co., Minneapolis, Minn. ★ International Water Corporation, Pittsburgh, Pa. ★ International Water Supply, Ltd., London, Ont., Can. ★ Layne-Hispano Americana, S. A., Mexico, D. F.

were spotted at the Armory door, uncoupled, and then stripped of tires and rims. The front end of a trailer was lowered as far as possible and placed on casters. The big fork-lift truck then raised the rear end to provide one-inch clearance of the bare wheels, and eased the trailer through the door. The largest trailer had top clearance of one and one-half inches. After the show the procedure was reversed. Thanks to skillful handling the big show-vehicles came through without a scratch.

Spring Loaded Head Makes Curved Weld

A midwestern manufacturer uses a track-mounted Unionmelt welding machine to weld a seam on the curved front surface of a hot air furnace. The welding head is left free to swing but a restraining spring holds the guide wheel against the curved front section, thus keeping the welding rod in alignment with the seam.

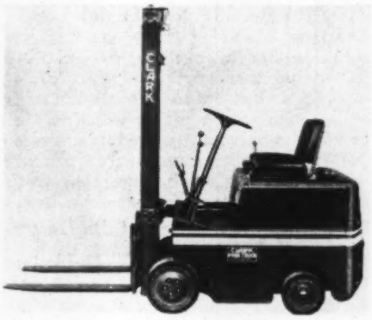


Welding rod and granulated welding composition are automatically fed to the welding zone. Welding takes place beneath a protective cover of welding composition without flash or spatter. The resultant weld is clean and uniform, and requires no subsequent chipping or peening. Welding speed for this application is approximately 46 in. per minute.

The speed and uniformity of this process of welding led the manufacturer to introduce it wherever possible in his production line. Special fixtures were made so that the round top and the vertical side seams could also be welded by this process.

Greater Capacity and Compactness Features of New Clark Gas-Powered "Clipper"

Increased capacity within approximately the same dimensions is the principal news concerning a redesigned gas-powered Clark "Clipper" model, 2000-lb.-capacity fork-lift truck, announced in a recent bulletin issued by Clark's Industrial Truck Division.



The new Clipper has a capacity of 2000 pounds with load center at 24 inches from the heel of the forks. The truck's wheelbase is 36 inches, and the frame has been widened

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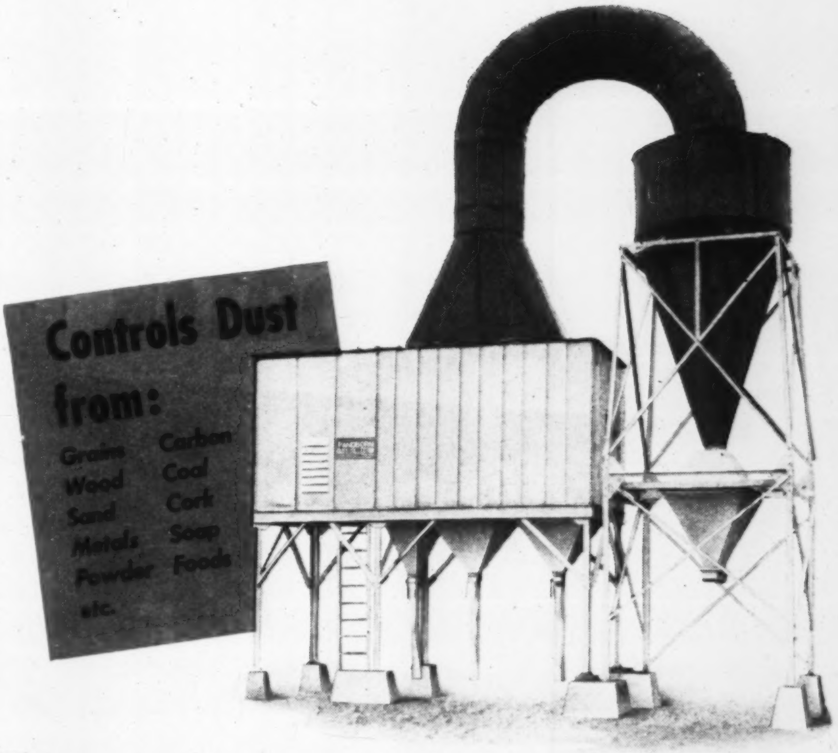


You can

ELIMINATE DUST

earn more profits

with PANGBORN Dust Control

RIGHT—you can eliminate dust problems in your plant and earn a profit at the same time with Pangborn Dust Control. Pangborn removes dust from working areas, protects employees, safeguards raw materials, improves your product, boosts production, recovers valuable materials for re-sale or re-use. Pangborn systems really pay off!

Hundreds of Pangborn units in all types of industries are proof that Pangborn helps you make a profit out of dust problems. A metal specialties plant saves $8000 every year with Pangborn . . . a furniture factory reports over $6000 annual savings with Pangborn on the job . . . savings on materials salvage pays for two Pangborn units for soap maker . . . foundries claim efficient operation is practically impossible without Pangborn dust control.

FIND OUT ABOUT YOUR PLANT!

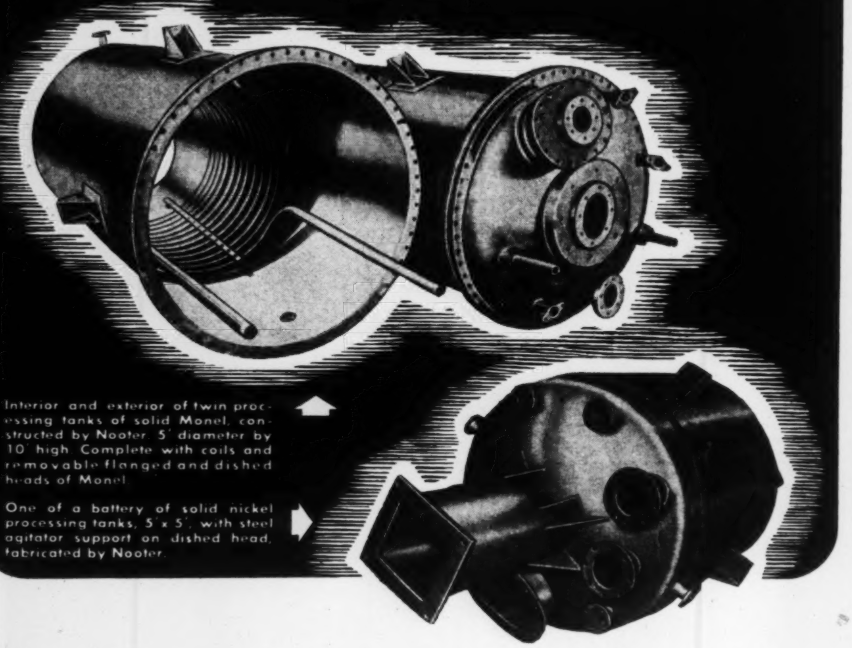
Skilled Pangborn engineers will make a *Dust Pocket Survey* of your plant at no cost to you. The survey may show you how you can save money and get rid of dust all at the same time! Write for complete information on Pangborn Dust Control, Bulletin 909A to, PANGBORN CORPORATION, 289 Pangborn Blvd., Hagerstown, Maryland.

Look to Pangborn for the Latest Developments in Dust Control and Blast Cleaning Equipment

STOP THE DUST HOG from stealing profits with

Pangborn

DUST CONTROL



THE RIGHT COMBINATION FOR BETTER FABRICATION

NICKEL+NOOTER

Interior and exterior of twin processing tanks of solid Monel, constructed by Nooter. 5' diameter by 10' high. Complete with coils and removable flanged and dished heads of Monel.

One of a battery of solid nickel processing tanks, 5' x 5', with steel agitator support on dished head, fabricated by Nooter.

You specify a specific metal *because* you know it has the *properties* needed for the job to be done. Now how about the fabrication of that metal so that those vital properties will be preserved and used to best advantage? That very question is what brings Nooter on the job! Making metals behave and do what they are supposed to do has been Nooter's specialty for over 50 years.

Call in Nooter at the blue print stage—for safe, accurate fabrication of your processing vessels.

NOOTER ST. LOUIS

Send for your copy of "Tank Fabrication for Industry" and Corrosion-Data Charts.

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slightly to provide greater protection for the wheels and to give more space for servicing but overall width is only one inch larger. With the longer wheelbase, additional weight is put on the drive wheels thus providing increased traction and improved performance. Grades of as much as 15 per cent can be climbed without difficulty.

Mechanical improvements include a new engine of 30 per cent higher brake horse power and increased torque; a new and improved oil sump and valve for operating hydraulic equipment; and greater strength and stability in the frame-steering-axle-engine assembly. The floor board is slanted for easier driving and a leather-upholstered air-inflated seat with back rest provides maximum driver comfort.

The gas-powered Clipper 2015 will continue to be available.

Literature on the new gas-powered "Clipper-2024" is obtainable on request to Clark Equipment Co., Industrial Truck Div., Battle Creek, Mich.

Penta-Kleen Eraser

U.S.A.
Penta-Kleen
EBERHARD FABER
1590

Eberhard Faber Pencil Co., 37 Greenpoint Ave., Brooklyn 22, N. Y., are now introducing a new item. It's the No. 51 Penta-Kleen Eraser. This eraser is made of a new compound that minimizes crumbling and eliminates smears.

Notice its unique design. It has 5 flat sides which are excellent for cleaning broad surfaces. Then too, its 10 sharp corners and 5 knife-like edges are ideal for the most exacting erasures. Penta-Kleen won't slide, slip or roll on tilted surfaces or drawing boards.

Gardner-Denver Announces New Air Starters

A new line of air starters for gas, gasoline or Diesel engines—including five sizes, developing from 3 to 15 horsepower on 100 pounds air pressure—has just been announced by Gardner-Denver Co. at Quincy, Illinois.

The principal advantages of these air starters, Gardner-Denver officials explain, are their extremely high torque and the elimination of costly battery maintenance and replacements. The high torque characteristic of the piston type motor, it is said, makes it especially desirable for Diesel applications involving high starting loads, while the 5-cylinder radial design provides even torque through the operating cycle.

An exclusive Gardner-Denver feature is an air actuated starter pinion which, when the air valve is open, automatically engages the ring gear a split second before the starter begins to crank the engine, thus assuring positive and safe engagement.

Canadian Plant Installs Large Combined Expanding and Tube Testing Machine of New Design

The Page-Hersey Tubes Ltd. in Welland, Ontario, has placed an order for a very large Tube Testing and Expanding Machine with Hydropress, Inc., 570 Lexington Ave., New York, N. Y., the well-known designers and builders of Heavy Hydraulic Equipment. Designed by Hydropress for a high and very

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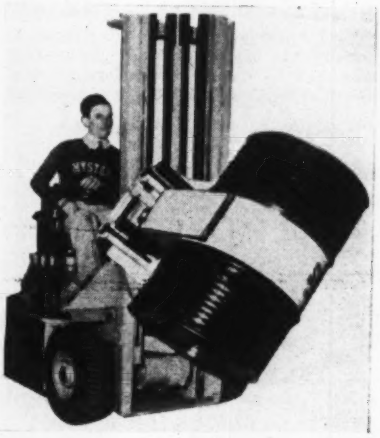
economical production, this fully automatic machine will perform three operations in one, namely belling, expanding and testing tubes ranging up to 16" diameter and 51 feet length.

Hydropress has at present several other Tube Testing Machines under construction.

Hyster Revolving Apron Attachment

A Revolving Apron attachment which makes possible the turning over or dumping of lift truck loads by a hydraulic mechanism is now available for the Hyster "20" and "40" (2,000 and 4,000 pound capacity) lift trucks.



Hydraulically controlled, a revolving head or turn-table on which conventional fork arms are mounted, turns 180 degrees in either direction from the center. Capacity loads of 1,725 pounds with the "20" and 3,650 pounds with the "40" may be efficiently turned with the device.

An important feature of the Revolving Apron is that a special Load-Grab unit may be mounted on the turn-table of the "20" lift truck in place of regular fork arms. The Load-Grab, an attachment which side-squeezes loads with sufficient pressure to lift securely without the need of any type of pallet, has a number of optional, special-purpose arms which may be substituted for the standard load arms as desired. These particularized arms, designed for handling such unit packages as bales, boxes, crates, drums, barrels, cartons, etc., when mounted on the Revolving Apron produce a great variety of combinations for the lifting, turning and tiering of many kinds of materials.

Load capacity of the Apron in conjunction with the special Load-Grab unit is 1,400 pounds.

Additional information may be obtained from the Hyster Co. of Portland, Oregon, Peoria and Danville, Ill.

• *BUSINESS CHANGES*

Cochrane Acquires Liquid Conditioning Corporation

Cochrane Corp., Philadelphia, manufacturers of water conditioning equipment and steam specialties, announces the acquisition for cash of substantially all of the capital stock of Liquid Conditioning Corporation, of Linden, New Jersey, which manufacturers a complete line of equipment for the conditioning of water and other liquids, under the trade name, "Liquon". Hereafter, Liquid Conditioning Corporation will operate as a wholly owned subsidiary of Cochrane Corporation, the products of the former continuing

Continued on Page 58

Do You Really KNOW
When Tools Need Sharpening?

With the PROFILOMETER, You're SURE!

If you keep track of the condition of your tools by gaging the parts produced, you're likely to get some off-size pieces before resharpening. This is because, when a cutting edge or grinding wheel starts to grow dull, clean cutting action ceases and the metal begins to be *torn* off. *Once begun, this effect increases rapidly,* often leading to off-size work before it is detected by dimensional measurement.

If, instead, you resharpen on a fixed-schedule basis, you again run the risk of loss. If the schedule is based on using a *normal* tool or wheel, one that is even slightly defective will produce rejects before resharpening. Unexpected changes in hardness of metal or in other operating conditions may also cause premature dulling, with the same result. If the resharpening schedule includes a factor of safety to allow for such possibilities, most of the time resharpening will be done more frequently than necessary, thus shortening total tool life and increasing your down-time.

To avoid these difficulties—to get maximum production with maximum tool life and minimum rejects—more and more companies are using the Profilometer to detect the dulling of tools and wheels. This is how it is done:

As tools and abrasive grow dull, the cessation of clean cutting action (mentioned above) increases the normal point-to-point variation in the *surface roughness* of the work. This takes place just before *dimensional* errors occur. *By taking occasional roughness readings with the Profilometer on the parts as they come from the machine, the operator can quickly tell the condition of his tools or wheel. When the point-to-point roughness increases, he knows it's time to sharpen his tools or dress his wheel.*

Using the Profilometer, this simple shop procedure can be applied to any machining, grinding or finishing operation on practically any surface. The initial cost of the Profilometer is soon repaid by the savings effected thereby; and that is only one of many practical applications. *Write for further information*—and arrange for a demonstration in your plant.

Profilometer is a registered trade name.

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A SURFACE CONTROL INSTRUMENT BY

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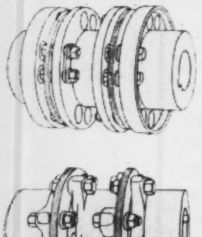
THOMAS
Flexible ALL METAL
COUPLINGS

Engineered to stand up on the toughest jobs, Thomas Flexible Couplings do not depend on springs, gears, rubber or grids to drive. All power is transmitted by direct pull.



The standard line of Thomas Couplings meets practically all requirements. But if unusual conditions exist we are equipped to engineer and build special couplings.

BACKLASH
FRICTION
WEAR and
CROSS-PULL
are eliminated
NO LUBRICATION
REQUIRED!

PATENTED
FLEXIBLE
DISCS

THE THOMAS PRINCIPLE GUARANTEES PERFECT BALANCE UNDER ALL CONDITIONS OF MISALIGNMENT

Write for New Engineering Catalog

THOMAS FLEXIBLE
COUPLING CO.
WARREN, PENNSYLVANIA

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to be marketed under the trade name, "Liquon".

According to T. E. McBride, president of Cochrane, the engineering, sales and technical staffs of the two corporations will augment each other. S. B. Applebaum, one of the organizers and an officer of Liquid Conditioning Corporation, and nationally known as an authority in the field of water conditioning, will be in charge of the cold water conditioning activities of both organizations, as well as the conditioning of liquids other than water. "Liquon" district sales offices are combining operations with existing Cochrane sales offices, thus further strengthening the field organizations of both corporations.

A New Oscillograph Service

The Engineering Development and Model Shop facilities of the Instrument Division of Allen B. Du Mont Laboratories, Inc., are now available and are offered to the industry for the development, design and construction of special cathode-ray instruments. The establishment of this service results from an increasing demand for special equipment and for special modifications of catalog items. Recognizing the importance of special instruments to the advancement of the art of cathode-ray oscillography, the Company has made its engineering design services and Model Shop facilities available for such work.

Further information may be obtained by writing to Allen B. Du Mont Laboratories, Inc., Instrument Division, 1000 Main Avenue, Clifton, N.J.

Farrel-Birmingham Appoints Detroit Representative

Farrel-Birmingham Co., Inc., announces the appointment of M. H. Blank as representative in the Detroit area to handle the sale of gears and gear units manufactured at the company's Buffalo, New York plant.

Mr. Blank, whose offices are located at 901 Lafayette Building, Detroit 26, Mich., has been engaged in sales engineering activities as manufacturers' agent in and around Detroit for the past few years. His previous business experience has centered around sales engineering and production development work with well known manufacturers of industrial and automotive equipment.

New D. J. Murray Representative

D. J. Murray Manufacturing Co., Wausau, Wis., announces the appointment of the following manufacturer's agents as distributors of GRID Unit Heaters and allied products in their respective territories: I. Ernest Shaer, 161 Devonshire St., Boston, 10, Mass.; G. T. Pottinger & Co., 2475 Rivers Road, N.W., Atlanta, Ga.; The Jordan Engineering Co., Traction Building, Cincinnati, 2, Ohio; Lefler Wyomont Supply Co., P. O. Box 2166, Casper, Wyoming.

New Diamond Chain Distributor for Boston

Chase, Parker & Co., Inc., 288-290 Congress Street, Boston, have been appointed distributors for the Boston area by Diamond Chain Co., Inc. of Indianapolis, makers of Roller Chains, Sprockets, Flexible Couplings, and Conveyor Chains.

Roller Chain Distributors Appointed by Diamond Chain Co.

In order to make its roller chain, sprockets and flexible couplings more widely available from stock, Diamond Chain Company of Indianapolis has widened its countrywide coverage with the following firms appointed distributors: Chicago, Ill.—Apex Power Equipment Co. and Ray M. Ring Co.

Silicone News
DC
SILICONES

DC 44 Silicone Grease Ends Bearing Failure in Textile Plant

Bearing failure may burn out your motors, stop your entire production line or ruin a mill run. That's why it's front page industrial news when the Plant Manager of a large textile plant reports that he has not had a single bearing failure since he started to use Dow Corning Silicone Oils and Greases over 30 months ago.

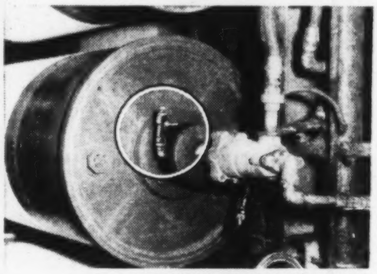
PHOTO COURTESY AMERICAN FINISHING COMPANY

DC 44 Silicone Grease in ball bearings on drying cans, operating at 400 r.p.m. around saturated steam journals, has 45 times the life of the organic grease previously used.

Typical of the lubrication problems that plague plant engineers in textile plants is the maintenance of "steam-heated" bearings. It used to be necessary to lubricate bearings on drying cans and the main cylinder bearings of Sanforizing machines once every 8-hour shift. Since American Finishing started to use DC 44, the re-lubrication schedule has been cut to once every 30 to 45 shifts. The lubrication of Slashers on textile mills presented a similar problem that has been solved by using DC 44.

On tenter frame chains and races that travel through ovens at 400°F., petroleum oils carbonized so rapidly that the chains had to be cleaned periodically. That costly operation and the need for continuous lubrication have been eliminated by a weekly application of DC 710R Silicone Fluid.

American Finishing, like many other skillfully engineered companies, has found that Dow Corning Silicone lubricants more than pay for themselves in reduced maintenance costs. Increased production due to the virtual elimination of bearing failure is another one of the many bonuses Dow Corning Silicones pay to modern industry. For the most recent data on DC Silicone Greases phone our nearest branch office or write for data sheet No. D5C.

DOW CORNING CORPORATION
MIDLAND, MICHIGAN
Atlanta • Chicago • Cleveland • Dallas
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In Canada: Fiberglas Canada, Ltd., Toronto
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Dow Corning
FIRST IN SILICONES

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Detroit, Mich.—W. F. McGraw & Co. Akron, Ohio,—Century Supply & Equipment Co.; Billings, Montana,—Hines Bearing & Industrial Supply; Columbus, Ohio,—The Ross-Willoughby Co.; Toledo, Ohio,—Ralph Shawaker Co.; Kalamazoo, Mich.,—Joseph E. Loughead Co.; Greenville, S. C.,—J. W. Vaughan Co.; Erie, Penna.,—Crossley Co.; El Paso, Tex.,—The Mine & Smelter Supply Co.; Albuquerque, New Mexico,—The Harry Cornelius Co.

R-S Products Appoints New Representative in San Francisco

R-S Products Corp., Philadelphia, has appointed the Trident Engineering Co., San Francisco, Calif., as representatives of the Valve Division.

• LATEST CATALOGS

Turbo Pumps

The J. S. Coffin, Jr., Co., 326 South Dean St., Engelwood, N. J., manufacturers for more than 25 years of high-speed, single-stage turbo pumps, now have available a four-page Bulletin describing their types CC and CG pumps. These two models, carry the following ratings* (boiler feed): Steam Pressures to 850 PSI, Back Pressures to 200 PSI, Pump Capacities to 500 GPM, Discharge Pressures to 1100 PSI (Heads to 2500 feet), Liquid Temperatures to 300° F. *Individual ratings are maxima and do not necessarily go together.

These pumps are finding increased application opportunities throughout industry for boiler feed duty, condensate (high pressure), oil refinery charge, and other instances where compact, rugged design with high-speed, high-pressure operation is required. Coffin's Bulletin "S" gives not only a complete description but cross-section illustration of the pump, running gear, governor detail, and pictures of other Coffin Pumps, notably Types "F" and "G" and "B" and "BL". Write for Bulletin "S".

Edward Issues New Strainer Bulletin

East Chicago, Ind.—A new Edward bulletin, No. 712, providing information on forged steel strainers has been issued by Edward Valves, Inc., East Chicago, Ind. Edward strainers have an ASA rating of 600 lb at 850 F for steam, oil, or vapor, and a hydraulic rating of 1440 lb at 100 F.

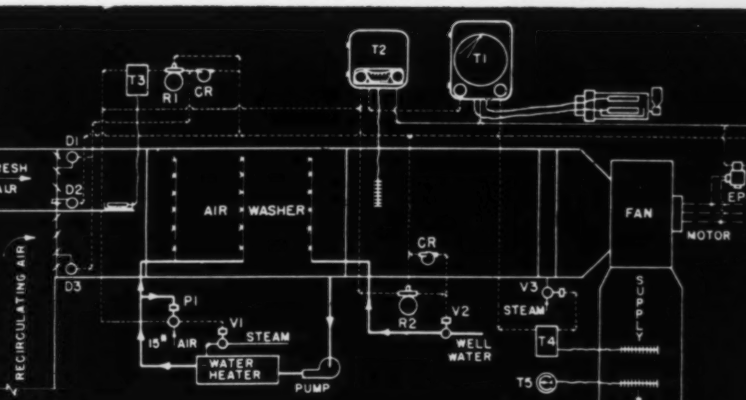
Bulletin 712 contains complete information on dimensions and weights, correct installation, maintenance, and cleaning.

Dillon Illustrates Dynamometer Uses in New Bulletin

Clear and interesting illustrations by actual photographs, of Dillon Dynamometers in a wide range of uses, form an attractive feature of the new Bulletin D, just issued by the manufacturers. The Dillon Dynamometer is said to now be considered essential equipment in many industries as well as in the power and communications fields. New uses are constantly being reported by almost every industry, large or small who, as they become familiar with it, state that it has proven valuable in many different operations.

It is a remarkable instrument—ruggedly constructed for measuring traction, tension, or weight from 0–500 lbs., to 0–20,000 lbs. with the closest accuracy. A distinct departure from ordinary "spring" measuring devices, it operates through deflection of a special alloy steel beam, and requires only .040" movement to indicate a full scale

Continued on Page 61



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AIR CONDITIONING CONTROL

with year 'round accuracy of 1°F. plus or minus regulates over 300,000 C.F.M. at—

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(T-1) POWERS WET AND DRY BULB RECORDING-CONTROLLING PSYCHROMETERS at Uxbridge Worsted Mill regulate—

One 100,000 C.F.M. fan system
" 80,000 " " "
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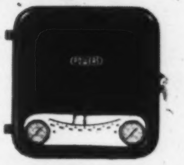
(T-2) POWERS INDICATING SUB-MASTER DEWPOINT REGULATORS automatically control the airwashers

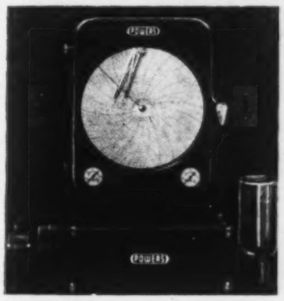
POWERS dampers, valves, relays and other devices are used with T-1 and T-2 to obtain the accurate control mentioned above.

20 to 30% Increase in Efficiency—claimed for modern air conditioning installed in carding, spinning, winding, weaving and sewing departments in Uxbridge, Mass., Mill. Dry bulb temperature of 78° F. and Wet bulb at 68° F.—accurately maintained at all times by POWERS control—helps produce a better product at lower cost.

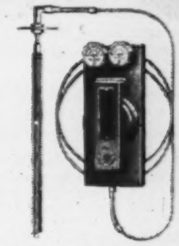
For Better Air Conditioning Control and valuable aid in selecting the right equipment for your requirements contact our nearest office: BOSTON, 125 St. Botolph St.—NEW YORK, 231 E. 46th St.—PHILADELPHIA, 2240 N. Broad St.—GREENSBORO, N.C., Jefferson Standard Bldg.—ATLANTA, 142 Spring St.—Also BIRMINGHAM and NASHVILLE. (ACU)

A FEW OF THE MANY DIFFERENT TYPES OF POWERS CONTROLS

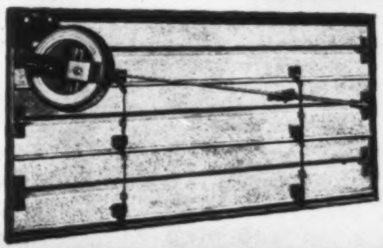




Above: T-2 Powers Series 100 Sub-master Dewpoint Indicating Regulator.
At Right: Powers Series 100 Wet and Dry Bulb Recording-Controlling Psychrometer.
Below: D-1-2-3 Powers Louvre Damper.



Above: T-3-4 Powers Type K Remote Bulb Thermostat.
Below: T-5 Powers Remote Bulb Dial Indicating Thermometer.



V-1-2-3 Powers Diaphragm Valve

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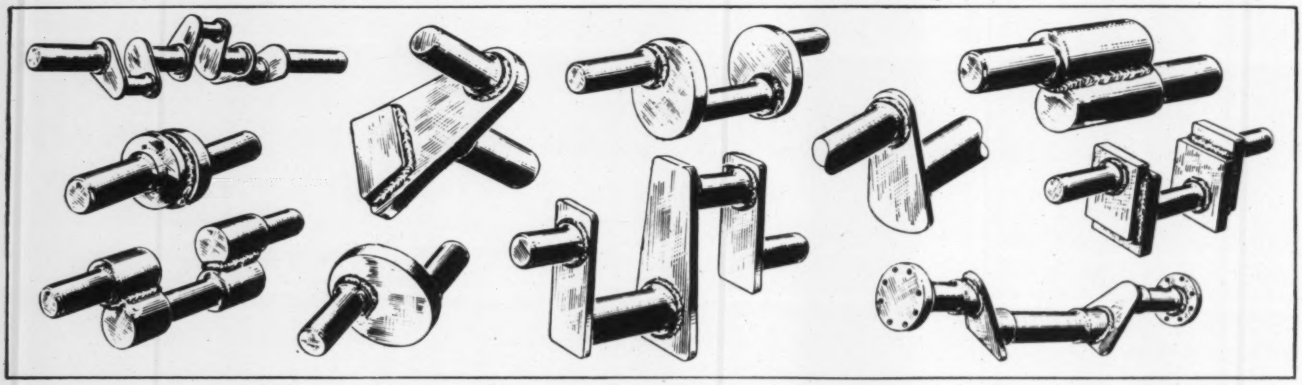
How Stronger Cranks Are Built at Lower Cost with Arc Welding



Examples of cranks and crankshafts fabricated from steel at lower cost with arc welding.

Many machinery parts like these simple cranks are being fabricated from standard steel shapes, eliminating the need for forgings or castings. Shaft components for the cranks may be produced from bar stock, machined to form as simple lathe operations, and throw members flame-cut from steel plate. Component parts are tack welded first or are located in simple fixtures for welded assembly using electrodes suited to the type of steel used.

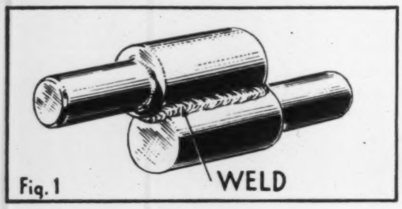


Fig. 1

Simplest of all cranks is shown in Fig. 1. Where accuracy of throw is unimportant, bars having a diameter equal to the throw can be fillet welded. If a longer crank throw must be maintained, the shafts can be fillet welded to a disc (Fig. 2) or two studs machined as shown in the lower sketch (Fig. 2) can be positioned back to back and the flanges fillet welded.

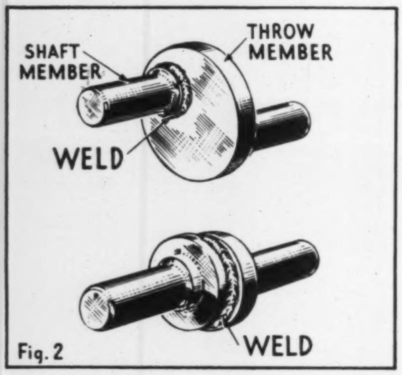


Fig. 2

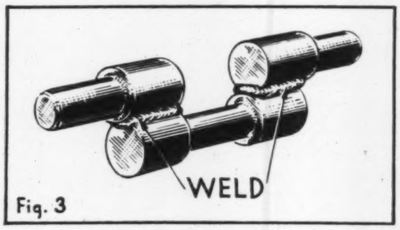


Fig. 3

Fig. 3 shows the elements of a single-throw crankshaft. On applications where the throw of the crank exceeds the diameter of the shaft members, discs cut from bar stock or flame-cut from steel plate are incorporated (Fig. 4).

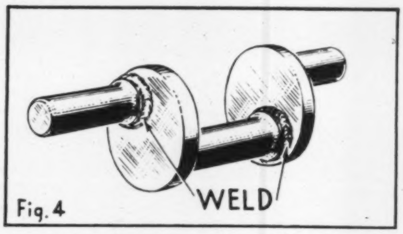


Fig. 4

To simplify the welded assembly of a crankshaft, the throw members can be built from rectangular stock and fillet welded as shown in Fig. 5, after which a trim cut may be taken on a lathe for appearance or balance.

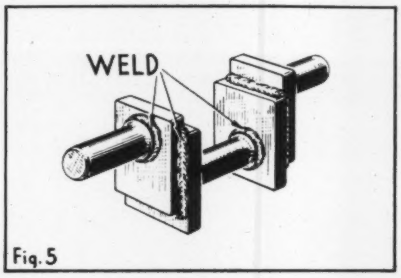


Fig. 5

Multiple throw crankshafts, as illustrated in Fig. 6, can be weld-fabricated to suit any requirements of size and throw. If necessary, different alloys can be incorporated in various component members to best suit the needs of the crankshaft. After welded assembly, the crankshaft can be machined all over in the conventional manner, accurately holding any size and throw specified.

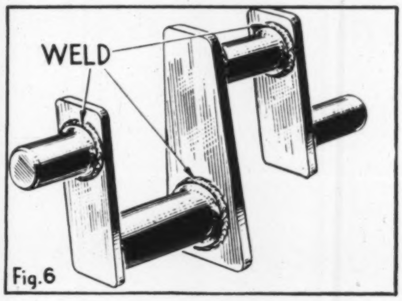


Fig. 6

Counterbalancing is easily accomplished by fillet welding weights to throw members as indicated in Fig. 7. Small deposits of weld metal can be added to any part of the crankshaft if unusually accurate balancing must be attained.

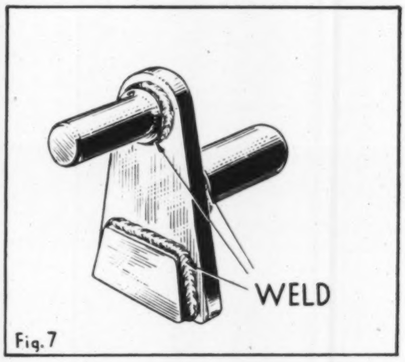


Fig. 7

The above is published by **THE LINCOLN ELECTRIC COMPANY** *in the interests of progress.*
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reading. There are no levers nor weights to adjust. Although tolerance between beams is less than .005" each instrument is individually calibrated.

It is fatigue protected—overload protected up to 25%—unaffected by temperature—and durably finished in baked-on gray enamel. It can be adjusted to fit every condition of use. Case is heavy metal. The large clear dial is instantly read.

Copies of the new Bulletin D may be had by addressing W. C. Dillon & Co., Inc., 5410-ME W. Harrison St., Chicago 44, Illinois.

Management Problems

"Management Problems" is a booklet of about 1500 words that outlines some of the problems involved in good business management. The main headings are Production, Labor, Product Sales, and Administration. About two-dozen subheadings permit a brief discussion of how manufacturing costs may be reduced. Gregory M. Dexter, Consulting Civil and Mechanical Engineer, Empire State Building, New York 1, N. Y.

Refractory Castables, Plastics and Mortars

The Babcock & Wilcox Co. announces the publication of a new booklet on refractory castables, plastics and mortars. This comprehensive combined bulletin on a wide range of important refractory materials describes the products, outlines their characteristics, and indicates typical applications. Many of the products are suitable for temperature as high as 3000F, and one "Kromecast," for as high as 3100F. Illustrated with many photographs and tables of properties and required quantities, this 18-page bulletin will be helpful to designers, builders, and operators of all types of industrial furnaces.

The booklet contains a complete section on refractory castables, including the new high temperatures materials which are designed primarily to reduce cost of furnace construction and maintenance. Detailed notes on the application of each product are furnished with a practical table of materials and typical uses. These, with an analysis of properties of B & W Refractory Castables, are also included as an aid in proper selection for specific needs.

Data is given on B & W Refractory Plastics, what they are and when they should be used. An outline of the properties of these high temperature plastics shows why they are especially adaptable for severe furnace conditions.

Refractory mortars are thoroughly reviewed. Considering that the life of any furnace is determined not only by the quality of the firebrick, but is also directly affected by the properties of the mortar in which it is laid, the characteristics of refractory mortars are important. In this bulletin the properties and qualities of the several types of B & W Refractory Mortars are presented with a convenient chart for selecting and ordering the material suitable for each requirement.

This handy reference, known as Bulletin R-22, may be obtained by writing to the Babcock & Wilcox Co., Advertising Division, 85 Liberty Street, New York 6, N. Y.

New Air Operated Press

A bulletin to provide production engineers and executives with detailed information on the operation and use of its new air operated "Han-D-Press" has just been released by Hannifin Corp. of Chicago. This press, which is available in 1/2 ton and 1 ton sizes, is especially designed for production assembly, staking, pressing, marking, riveting and other light operations. It is arranged for electric push button control through a fast-cycling, piloted operated valve and is suitable for use on ordinary shop air supply. Other features of the press include removable steel base plate for making changes in work set-ups through use of alternate work bases, guided ram with easy means for attachment of tools or fixtures, and a speed control valve for the ram. Copies of the new bulletin may be secured by addressing requests to Hannifin Corp., 1101 So. Kilbourn Ave., Chicago 24, Ill., for Bulletin No. 251.

New Speed Reducer Bulletin Issued by Farrel-Birmingham

A new, 44-page bulletin just issued by Farrel-Birmingham Co., Inc., Buffalo, New York, contains complete information about the company's line of speed reducers which are now offered in a wider range of sizes and capacities.

The new bulletin gives simple, easy-to-understand directions for selecting speed reducers of the horsepower and speed required, and will be of interest and practical value to engineers responsible for the selection, operation, and maintenance of power transmission units. Contents include complete descriptions of units of the single and double reduction types, specifications, horsepower rating tables, overhung load capacities, dimemsions and weights.

Among the features of these units which contribute to smooth, efficient, power transmission are precision-generated, Farrel-Sykes continuous tooth herringbone gears; oversized, accurately ground shafts properly mounted in roller bearings, and heavy section cases that hold rotating elements in precise alignment.

Copies of Bulletin No. 449 will be sent without charge upon request to the company's gear plant at 344 Vulcan Street, Buffalo 7, New York.

Heat Controls

Fenwal, Inc., 50 Pleasant St., Ashland, Mass., offers catalog on unique "Thermoswitch"* Heat Control, a precison thermostat having outstanding advantages of instant response, high accuracy, wide range, rugged construction and ease of installation. Temperature-sensitive element is external metal shell which actuates and protects internal contacts. Catalog describes wide application and gives full engineering details, and shows how "Thermoswitch"* can often replace expensive control instruments. (*Reg. U. S. Pat. Off.)

New Materials Handling Methods and Equipment Feature Recent Clark Literature

How industry is making ever-increasing use of modern mechanized equipment as a means of cutting production costs and conserving working capital is described and illustrated in recent literature published by the Industrial Truck Division of the Clark Equipment Co.

Material Handling News, Vol. 6, No. 3, known as the "Case Histories" issue, describes fork-truck applications in beverage, building materials, plumbing supplies, monuments, petroleum products, farm implements, marine warehousing, canneries, retail warehousing and ceramic products installations and operations. Material Handling News, Vol. 7, No. 1, entitled "Looking At Clark From All Angles," presents a simple but comprehensive analysis of the mechanical principles of the fork-lift truck; and takes Clark machines apart, unit by unit, with

Continued on Page 62

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By *Carl Samans*. A complete, clear knowledge of modern metals—their production, fabrication, characteristics, and basic theory—is given in the form most useful to design and purchasing engineers. Here you will find what you want to know on new high-strength, light metals, alloys resistant to corrosion or abrasion, and all other alloys now available for special engineering needs. This book will enable you to be sure you are solving your materials problems in the most efficient, economical way. $7.50

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emphasis on the important basic facts that should be known by all users and prospective users of such equipment.

General Catalog—a fully detailed description of all models of Clark fork-lift trucks, towing tractors and a variety of attachments designed for special handling needs.

"Dynatork" Bulletin—an 8-page announcement of the new and revolutionary "Dynatork Drive" which eliminates the clutch and which propels the fork-lift truck by electro-magnetic induction through an air gap to a constant-mesh transmission. The "Dynatork Drive" presently is offered only on Utilitruc models.

Copies of these publications will be mailed promptly upon receipt of request by the Clark Equipment Co., Industrial Truck Division, Battle Creek, Mich.

Cochrane C-B Condensate Drainage Control System

Cochrane Corp., Philadelphia, has announced publication of an expanded 24-page bulletin on high pressure condensate return systems. Data on steam flow conditions and heat exchange characteristics make the technical portions of this new book particularly useful to engineers responsible for the efficient transfer of steam heat in heating, cooking, drying, and pressing operations.

To accomplish the return of condensate to higher pressure boilers from presses, dryers, and other steam heated process equipment, Cochrane engineers have developed the new high differential condensate return system to supplement the standard unit. In addition to material and operating specifications capacity ratings are given for both standard and high-differential units in the six different sizes available—3, 5, $7\frac{1}{2}$, 10, 15 and 25 hp—based on a maximum of 200 psi above process pressure. Differential pressures to 200 psi are listed and capacities for each unit are tabulated after each differential pressure for unit inlet pressures varying from 0–39 psi, 40–99 psi and for over 100 psi. Dimensioned drawings in color show the design and construction of the two types of drainage control units.

The closed circuit from the boiler, through the process equipment, and back to the boiler results in quicker and more uniform heating hence increased production and improved quality. At the same time flash loss is eliminated providing 1% fuel savings for each 11-degree temperature gain.

Write Cochrane Corp., 3142 17th St., Philadelphia 32, Pa., for a copy of Publ. #3250. In Canada, address Canadian General Electric Co., Ltd., 212 King Street West, Toronto, Ontario.

B & W Tube Co. Offers Data Table on Working Pressures

Maximum allowable working pressures for water-tube and fire-tube boilers have been assembled by The Babcock & Wilcox Tube Company in the form of a useful table which will serve as a handy reference. The table lists the maximum allowable working pressures in pounds per square inch for seamless and electric-resistance welded carbon steel tubes or nipples for different diameters and gages of tubes conforming to certain A.S.M.E. specifications. This technical data card #113 is available free on request to The Babcock & Wilcox Tube Co., Beaver Falls, Pa.

Bailey Multi-Pointer Gages

Latest developments in Bailey Multi-Pointer Gages are described in Bulletin No. 163-B which is now being distributed by Bailey Meter Co., 1026 Ivanhoe Road, Cleveland, 10, Ohio.

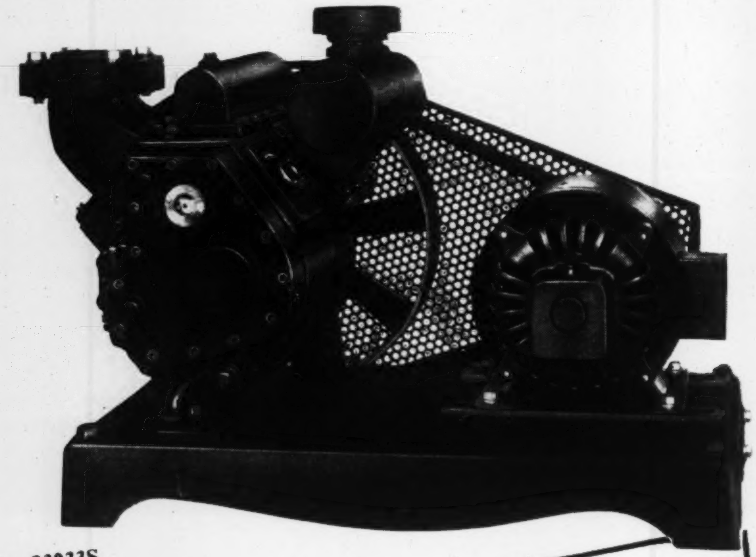
Use of the diaphragm operated unit for measurement of pressure, draft or differential is explained in detail and some of the many standard ranges available are listed. Described in detail are four styles of casings, all of which are available in sizes to accommodate from one to twelve units. Data includes net and shipping weights plus complete dimensions of casings.

The bulletin has numerous illustrations including photographs, diagrammatic drawings, and cut-away drawings.

Thought Starters on Cutting Factory Costs Available Through Lincoln Electric

To present interesting case histories and ideas on how to use arc welding most effectively in cutting factory operating costs and production costs, The Lincoln Electric Co., Cleveland 1, O., is publishing an 8-page rotogravure news sheet. "It's Welding Time" is issued regularly and is sent free to factory personnel interested in cutting the costs for which they are responsible.

"It's Welding Time" is edited and prepared not to present detailed explanations of how to do specific jobs, but is intended rather to be a thought starter for the cost conscious



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Write Dept. B.D. for Engineering Bulletin 10 describing Cenco High Vacuum Pumps, Gages and accessory equipment, including prices.

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plant superintendent, plant engineer, master mechanic, methods engineer and maintenance engineer. The issue now being distributed contains over 50 photographs and drawings showing how plants in all parts of the country are using arc welding. Illustrated are: maintenance ideas—how machinery is kept operating efficiently; design ideas—how better products are made at less cost through welded design; building ideas—how welding permits easy erection and maintenance of plant capacity; equipment ideas—how special plant equipment is made for special production jobs.

"It's Welding Time" is sent free of charge to those interested by writing to The Lincoln Electric Co., Cleveland 1, Ohio, on your letterhead.

Combined Standard Steel Lists Published by B & W Tube Co.

Standard steel lists combined in one data folder are offered by The Babcock & Wilcox Tube Co. Chemical compositions are given for basic open-hearth and acid-bessemer carbon steels and resulphurized steels, for open-hearth and electric-furnace alloy steels and for stainless and heat-resisting steels, all subject to standard variations for check analysis. Giving the AISI number with the SAE number, these are convenient lists for cross reference. Technical data card #119 is available free on request to the company at Beaver Falls, Pa.

Small Size Venturi Tubes

Republic Flow Meters Co., 2242 Diversey Pkwy., Chicago 47, Ill., announce the design of fabricated Venturi tube assemblies for line sizes between $^3/_4''$ and 3". These are supplied with welding ends, with stub end welding nipples for measurement connections. They can be furnished in steel, stainless steel, Monel, brass, bronze or any other metal which can be obtained in tubular and bar forms, and which can be readily welded or brazed.

These tubes are particularly useful where line fluid velocities are so high that excessive differential range is required with an orifice plate, or where solids in suspension in the line fluid tend to deposit in the space immediately ahead of or after an orifice, or on the orifice plate itself.

High Vacuum Apparatus

The Central Scientific Co. have issued a booklet on their high vacuum pumps, accessories and data. Included in this 48-page catalog are high vacuum engineering information; suggestions for planning a high-vacuum system; information on pumping speed; explanation of merit factor, connections and speed of evacuation, low pressure technique, and other data, together with a complete listing of Cenco mechanical pumps, D-P diffusion pumps and Cenco gages, oils, traps and other vacuum accessories. A copy may be obtained by writing Central Scientific Co., 1700 Irving Road, Chicago 13, Ill.

Resistance of High Nickel Alloys to Sulfuric Acid Corrosion

A new technical bulletin on the resistance of high nickel alloys to corrosion by sulfuric acid has been issued by The International Nickel Co., Inc.

While the bulletin is technical in nature, it is written so that it can be readily understood by non-technical as well as technical staffs of industries in which corrosion by this useful but highly corrosive agent is a problem.

Performance of over 30 different nickel-bearing materials in a wide range of services is discussed. Prepared by members of the

Continued on Page 64

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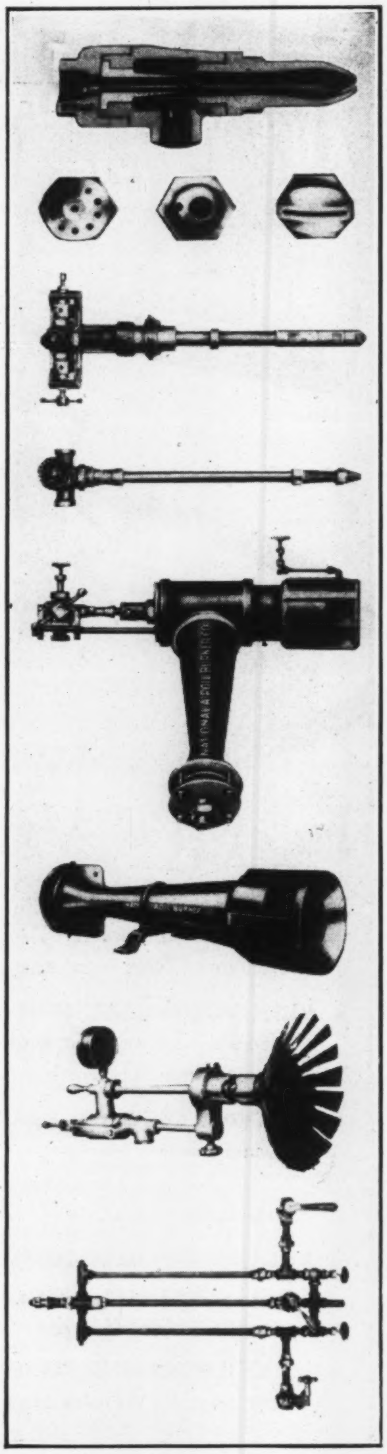

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Company's Corrosion Engineering Section, the bulletin contains 86 tables and 33 graphs and photographs in addition to text matter.

Problems involving such a wide range of operations from the pickling of steel to petroleum refining and textile processing are discussed. Known as Technical Bulletin T-3, it is available without cost through the offices of The International Nickel Co., Inc., 67 Wall Street, New York 5, N. Y.

New Roller Chain Catalog

A new, twelve-page catalog containing helpful information for all those connected with the use and specification of roller chain has just been published by Atlas Chain & Manufacturing Co.

Entitled "Atlas Roller Chain," this catalog describes new features for safety, wear, and maintenance found in Atlas Chain as well as its operating characteristics. Photomicrographs, engineering drawings, and component photographs illustrate construction from complete assembled chain down to metallurgical characteristics. Specifications and prices for most sizes of American Standard Roller Chain—and attachments—are also included.

Copies of this new catalog are available to your readers upon request. Atlas Chain & Manufacturing Co., Castor & Kensington Avenues, Philadelphia 24, Penna.

Hydraulic Weighing Cells

A new 8-page bulletin, No. 288, describes and profusely illustrates Emery hydraulic cells for general industrial weighing and special laboratory testing equipment. Six standard models, ranging in capacity from 10,000 to 100,000 lb., and special cells having load capacities from 40 lb. to 2500 tons are described. The bulletin also describes three self-contained, portable weighing units or scales with Bourdon tube indicators and several cell applications with the still more accurate Tate-Emery indicator. It includes illustrated descriptions of the principles of the Emery cell and Tate-Emery indicator.

Copies of the bulletin are available from The Baldwin Locomotive Works, Testing Equipment Dept., Philadelphia 42, Pa.

Fin-Fan Air-Cooled Heat Exchanger

Plant engineers and executives who are troubled with cooling water problems will be interested in a recent issue of The Griscom-Russell Co.'s G-R News which features the many applications of the Fin-Fan Air-Cooled Heat Exchanger. The publication describes and illustrates the design of this unit, in which the condensing or cooling elements are the helically-finned K-Fin Sections. Typical installations inside a building, on a roof and on the ground are also shown, with explanation of the reasons for the unusual adaptability of these units to any kind of location. Copies of the publication can be obtained by writing to The Griscom-Russell Co., 285 Madison Ave., New York 17, N. Y., and asking for the March issue of G-R News.

New Edition of
Cathode-Ray Tube Book

Allen B. Du Mont Laboratories, Inc., Instrument Division, Clifton, N. J., announce the publication of a new edition of their booklet describing the modern cathode-ray tube entitled, "The Cathode-ray Tube and Typical Applications."

Because of the tremendous demand for the previous edition of this booklet, the new edition has been made available generally to the trade through radio-parts jobbers at the monimal price of fifty cents.

• Keep Informed

The new edition of this booklet contains 63 pages of material relative to the history, development, design and structure, and the uses of the cathode-ray tube, and 68 illustrations. In addition, a full-page frontispiece reproduction of a wall chart depicting the modern cathode-ray tube is also included.

In addition to material on the cathode-ray tube as such, chapters on the cathode-ray oscillograph, television, and radar are contained in this booklet.

This booklet is available at all radio-parts obbers.

Edward Releases New Relief Valve Bulletin

East Chicago, Ind.—Bulletin 711, containing the latest information on forged steel relief valves, has been issued by Edward Valves, Inc., East Chicago, Ind. Included in this bulletin is complete information on dimensions and weights, design detail, and correct installation.

Edward all-steel relief valves are designed for a basic steam, oil, or vapor working pressure of 600 lb at 850 F, but can be furnished with special carbon springs for more severe service conditions.

High Pressure Solenoid Valves

Waterman Engineering Co., 721 Custer Ave., Evanston, Ill., announces a complete new line of solenoid valves for hydraulic systems with operating pressures to 3000 p.s.i. These valves are available in either two-way, three-way, four-way, normally open or normally closed type. Compactly built, they occupy a minimum amount of space and poppet type construction locks fluid in one direction, eliminating leakage. Free flow is admitted in the other direction. Electrical requirements are any voltage from 6 to 36 volts direct current.

Dillon Multi-Low-Range Universal Tester Serves Many Fields

Ultra-precision in four individual ranges permits the operator of the Dillon Multi-Low-Range Universal Tester to obtain close readings on its 8" dial. The scale is available in ounces, tenths pound, or kilos, four divisions each, with scale in different colors. A new bulletin M on this remarkable instrument has been issued by the manufacturer, W. C. Dillon & Co., Inc., 5410 W. Harrison Street, Chicago 44, Ill., and is available on request. Full description of the simple operation of the tester, with photographs of all parts, make this one of the most informative bulletins yet issued.

This moderately priced tester will accurately test paper, thread, fabrics, plastics, springs, film, cord, leather, wire, resins, adhesives, glass, wood, ceramics, cardboard, felt, bakelite, insulation—virtually any material light enough to fall within the range of its four scales.

Net weight of tester is 170 lbs. height 64". A sturdy metal stand is included. It can be easily moved about, and takes up little space. Entire assembly is finished in polished chromium and gray crackle.

Drop Forgings

Drop Forging Association has published recently a reference data booklet called "Metal Quality." This new 60-page booklet issued by the Technical Committee of the Drop Forging Association for users of forgings—design engineers, metallurgists and production and management executives. The booklet describes and illustrates the development of metal quality progressively throughout hot working operations, from the blast furnace to the finished forging. A

Continued on Page 66

NOW...

MADE IN USA
LUNKENHEIMER

Fig. 2140
GLOBE
125 lb. S.P.
200 lb. W.O.G.

125 lb. S. P. BRONZE GLOBE, ANGLE and CHECK VALVES
Built to **LUNKENHEIMER**
QUALITY STANDARDS

Want a lower pressure valve to give the same dependable, low-cost service you get in higher pressure LUNKENHEIMER Valves?

Here it is—New Fig. 2140 Globe; Fig. 2141 Angle; Fig. 2142 Lift Check; Fig. 2144 Swing Check. These valves feature Lunkenheimer's traditionally fine design and sturdy construction, plus exclusive silicon bronze alloy stems which eliminate stem thread failure due to wear.

Whatever your requirements for lower pressure service, you'll find these new valves unequalled for dependability and true economy.

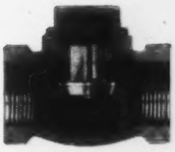

Fig. 2142 LIFT CHECK
125 lb. S.P. 200 lb. W.O.G.

Nowhere in the line is dependability more important than in Check Valves. These Checks function quickly and positively, seat accurately and tightly.

Your LUNKENHEIMER DISTRIBUTOR is stocking these new 125 lb. S.P. Bronze Valves. Call upon him for your original equipment, replacement and repair valve requirements. Ask him for Circular No. 582 or write direct.

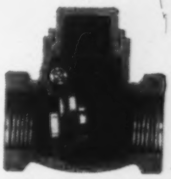

Fig. 2144 SWING CHECK
125 lb. S.P. 200 lb. W.O.G.

ESTABLISHED 1862
THE LUNKENHEIMER CO.
"QUALITY"
CINCINNATI 14, OHIO. U. S. A.
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EXPORT DEPT 318 322 HUDSON ST NEW YORK 13 N Y

discussion is presented of forging quality steel and the proper selection of metals for forgings. Steps in making forging dies and the various methods and equipment used in hot working steel by forging are reviewed. Forging procedures of various kinds of parts are outlined such as parts with thin sections, projections, holes, etc. Economic advantages of forgings are highlighted. Published by Drop Forging Association, 605 Hanna Building, Cleveland 15, Ohio.

Electronic Alloys

A new 26-page booklet describing the electrical and electronic properties of 18 high nickel alloys has been issued by The International Nickel Co., Inc.

Designed primarily for electrical engineers, it cites typical uses of these materials, their mechanical and other properties, and the various forms in which they are available.

Copies of the booklet can be obtained from The International Nickel Co., Inc., 67 Wall Street, New York 5, N. Y.

Steel Tubing for Food Process Industries Described in B & W Tube Co. Bulletin

A non-technical, informative bulletin on stainless steel tubing for the food processing industries as announced by The Babcock & Wilcox Tube Co. The bulletin points out methods of economically protecting food-product quality by preventing contamination through corrosion, erosion, chemical reaction, or inability to maintain proper sanitation in processing equipment where tubing is used. It presents grades, sizes, and finishes of stainless Croloy tubing developed for applications such as process piping, evaporating and condensing equipment, heat exchangers, precoolers, pasteurizing and sterilizing equipment, dairy equipment, transfer lines, and other related uses. Known as TA-1398, the bulletin is available free on request to The Babcock & Wilcox Tube Co., Beaver Falls, Pa.

Flexible Couplings

Crocker-Wheeler Electric Mfg. Co. Ampere 3, N. J.—Bulletin SL-1000-1A describes the patented Crocker-Wheeler resilient flexible coupling, which transmits torque through six composition rubber balls, and which requires no lubrication. The 4-page illustrated bulletin contains engineering data and complete dimensions.

Liquid Level Transmission

A new 4-page bulletin, "Taylor Force-Balance Liquid Level Transmitter," has just been announced by the Taylor Instrument Companies, Rochester, N. Y.

The new literature gives a clear and concise presentation of Taylor's Liquid Level Transmitter which is specifically designed to measure pressure and liquid level of viscous or corrosive liquids and liquids containing solids. It is particularly adaptable to open tanks as well as closed tanks under pressure or vacuum.

The bulletin explains the Transmitter's force-balance principle of operation with a diagram to point out its corrosion resistant construction design. Application drawings show how it is adaptable to different types of installations and also for flow measurement service. Graphs clearly illustrate the Transmitter's highly responsive performance and technical data on accuracy, temperature limits and pressure ranges are defined so that ordering directly from the bulletin is made easy.

Write for Bulletin 98069, "Taylor Force-Balance Liquid Level Transmitter." Taylor Instrument Companies, Rochester 1, N. Y.

Polyphase Motors

Crocker-Wheeler Electric Mfg. Co., Ampere 3, N. J.—The Company's line of Protected-Type squirrel-cage motors, available from 1 to 2000 hp, with a wide variety of mechanical and electrical modifications, is fully described and illustrated in the 12-page bulletin SL-300-1A.

Blast Furnace Gas Burner

In answer to the growing demand on the part of industry for ways and means to utilize waste fuels, Peabody Engineering Corp., 580 Fifth Ave., New York, N. Y., has just published a two-color bulletin on their complete line of blast furnace gas burners.

The bulletin includes not only blast furnace installation pictures but cross-section drawings of various other types of burners for waste and primary fuels. Copies of this Bulletin #500 are available upon request.

Data on Croloy Steels Ready

The Babcock & Wilcox Tube Co. now has available a convenient reference card on stainless Croloy steels for tubing, giving standard type numbers by which grades are identified, and chemical composition limits and ranges, based on ladle analyses.

The card, TDC-122, is available upon request to the company at Beaver Falls, Pa.

Improve Your Product THROUGH VIBRATION Fatigue Tests

MODEL 100VA
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YOU can definitely acertain how good your product is—substantiate construction and design—eliminate excessive material—through interpreting tests made on the All American Vibration Testing Machine. Eight models for handling parts or assemblies from 10 lbs. to 100 lbs. in weight. Models for vertical and horizontal movement of table. Vibration in simple harmonic motion. Standard machines produce frequencies of 600 to 3,600 v.p.m., manually or automatically controlled. Send for Catalog F. Special machines designed and built to meet your requirements.

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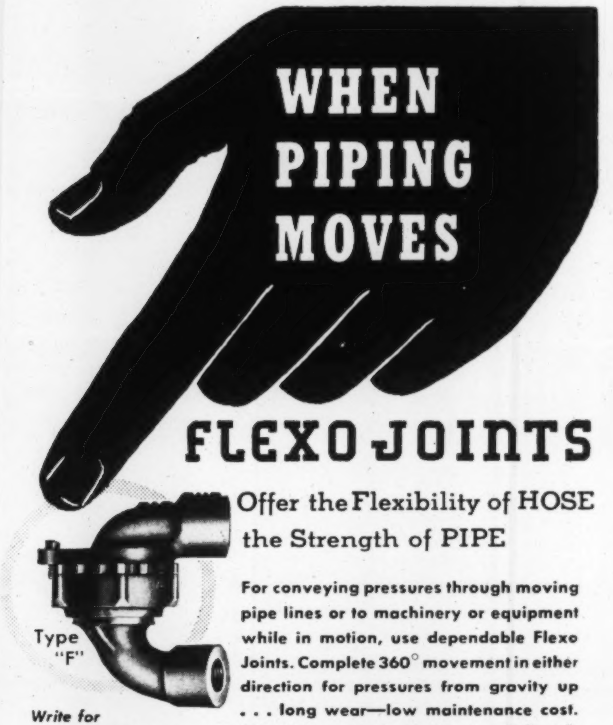

FLEXO-JOINTS

Offer the Flexibility of HOSE the Strength of PIPE

For conveying pressures through moving pipe lines or to machinery or equipment while in motion, use dependable Flexo Joints. Complete 360° movement in either direction for pressures from gravity up . . . long wear—low maintenance cost. Four styles—standard pipe sizes ¼" to 3".

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Bundyweld*... keyed to your tubular needs

Want an open door to faster production, lower costs, higher quality, or better design in your tubular applications?

Latch on to Bundyweld Tubing!*

Bundyweld, made of steel, Monel, or nickel, is double-walled from a single strip, and copper-bonded throughout . . . for extra-strong tubing that's lightweight, ductile and leakproof, too. It can be bent without fear of its weakening or collapsing structurally, and is easily fabricated.

Manufacturers in such diverse fields as television, radiant heating, refrigeration, ranges, tubular toys and automobiles—to mention only a few—have found Bundyweld to be the answer to their tubular needs.

Chances are that this miracle tubing of industry can help solve your manufacturing problem . . . whether design, structural, or functional . . . even though you may not seem to need a tubing at all. Why not give it a try? Contact your near-by Bundy representative among those listed below, or write direct to: *Bundy Tubing Company, Detroit 14, Michigan.*

BUNDY TUBING

ENGINEERED TO YOUR EXPECTATIONS ®

*REG. U. S. PAT. OFF.

WHY BUNDYWELD IS BETTER TUBING

1 Bundyweld Tubing, made by a patented process, is entirely different from any other tubing. It starts as a single strip of basic metal, coated with a bonding metal.

2 This strip is continuously rolled twice laterally into tubular form. Walls of uniform thickness and concentricity are assured by close-tolerance, cold-rolled strip.

3 Next, a heating process fuses bonding metal to basic metal. Cooled, the double walls have become a strong ductile tube, free from scale, held to close dimensions.

4 Bundyweld comes in standard sizes, up to $\frac{5}{8}$" O.D., in steel (copper or tin coated), Monel or nickel. For tubing of other sizes or metals, call or write Bundy.

BUNDY TUBING DISTRIBUTORS AND REPRESENTATIVES

Cambridge 42, Mass.: Austin-Hastings Co., Inc., 226 Binney St. • *Chattanooga 2, Tenn.:* Peirson-Deakins Co., 823-824 Chattanooga Bank Bldg. *Chicago 32, Ill.:* Lapham-Hickey Co., 3333 W. 47th Place • *Elizabeth, New Jersey:* A. B. Murray Co., Inc., Post Office Box 476 • *Philadelphia 3, Penn.:* Rutan & Co., 404 Architects Bldg. • *San Francisco 10, Calif.:* Pacific Metals Co., Ltd., 3100 19th St. • *Seattle 4, Wash.:* Eagle Metals Co., 3628 E. Marginal Way • *Toronto 5, Ontario, Canada:* Alloy Metal Sales, Ltd., 881 Bay St.

BUNDYWELD NICKEL AND MONEL TUBING IS SOLD BY INTERNATIONAL NICKEL COMPANY DISTRIBUTORS IN PRINCIPAL CITIES.

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helping hand
AIRCRAFT
JUKE BOXES
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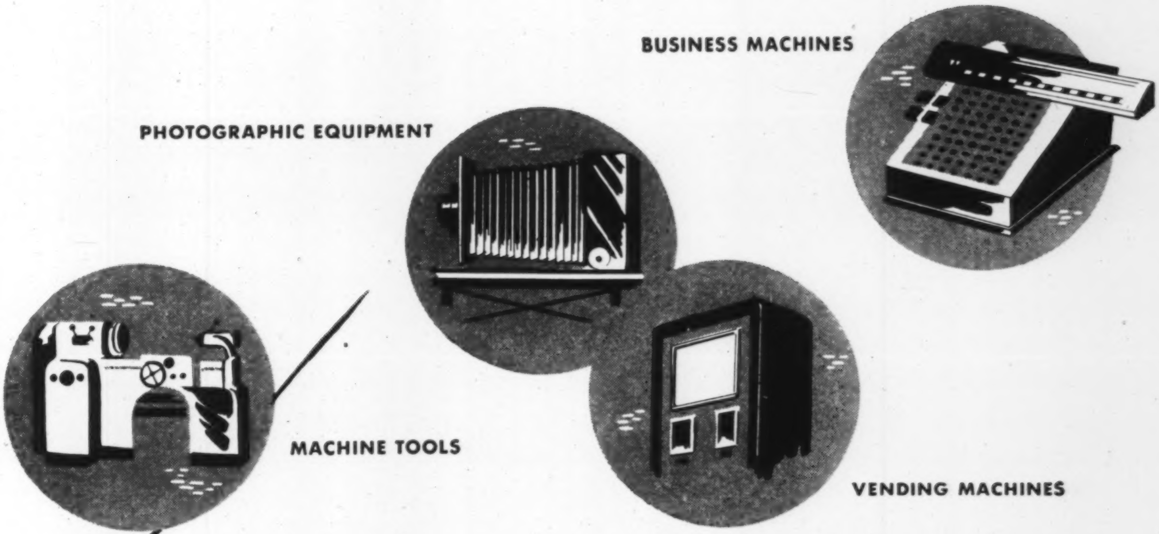
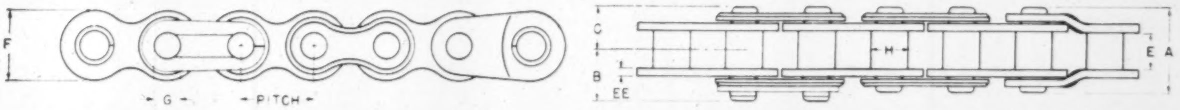


for machine designers!

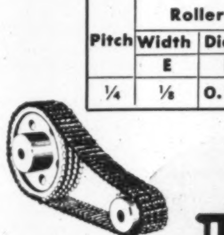
Machine designers! Here's the newest addition to the complete Baldwin-Rex line of precision-made roller chains. It is the answer to that problem of transmitting positive power where space is limited, where centers are extremely short, where savings in weight and a combination of high strength and accurate timing are required . . . Baldwin-Rex No. 25 Roller Chain. This ¼-inch pitch chain is as finely made . . . as long lasting . . . as versatile and positive as the larger size roller chains. And despite its small size, it has an ultimate strength of 875 pounds . . . an important advantage where reduced maintenance and service are needed.

Hand power tools, juke boxes, animated displays, machine tools, photographic equipment, electronic equipment, television equipment, business machines, model equipment and many other types of high precision, small size equipment can be more efficiently designed with this new helping hand to the designer. In many larger types of equipment, too, this handy little chain can motivate intricate timing functions that must be designed into small space.

For all the facts, write Baldwin-Duckworth Division of Chain Belt Company, 363 Plainfield Street, Springfield 2, Massachusetts.



Principal Dimens.			LIST PRICES				DIMENSIONS — INCHES								
	Roller									Side Plate				
Pitch	Width E	Diam. H	Riveted Chain Per foot	Connecting Link Each	Assembled Roller Link Each	Offset Link Each	Over-all Riveted A	From Pin End to C.L. B	From Pin Head to C.L. C	Thickness EE	Height F	Pin Diam. G	Average Ultimate Strength Lbs.	Average Weight per Foot Lbs.
¼	⅛	0.130	$1.10	$.14	$.10	$.40	0.31	0.19	0.15	0.030	0.23	.0905	875	.085



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a complete line from ¼-inch to 2½-inch pitch

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NEW AND REVISED PUBLICATIONS

of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
29 West 39th Street, New York 18, N. Y.

DIESEL LUBRICATING OILS AND BASIC PRINCIPLES OF LUBRICATION

By J. B. Rather, Jr., W. C. Hadley, Mayo D. Hersey

This publication makes available the two Pre-Conference Lectures presented in May of 1948 at St. Louis under the sponsorship of the ASME Oil and Gas Power Division.

The first lecture is an extremely clear and simple review of the steps involved in the manufacture and classification of lubricating oils—particularly with reference to their use in internal combustion engines of the Diesel type; the methods of testing new and used oils; the reasons for testing; and the general significance of the different test methods.

CONTENTS: Introduction; Manufacture and Classification; Vacuum Distillation; Acid Treating; Single Solvent Refining; Decolorizing; Processing and Intermediate Lube Distillates; Solvent Dewaxing; Processing the Lube Residuum; Removing Asphalt and Chemically Unstable Substances—Propane Deasphalting plus Single Solvent Refining; Duo-Sol Refining; Test Methods—including Laboratory Testing of Lubricating Oils Gravity, Flash Point, Viscosity, Viscosity Index, Water, Pour Point, Sediment by Volume, %, Ash Content, Neutralization Number, Color and Dilution; Significance of Tests; Interpretation of Test Results; Engine Testing; Summary; References; and Discussion.

The second lecture reviews the facts and principles of fluid film lubrication, and discusses their engineering applications. Some of the fundamentals and engineering applications of the principles taken up in this lecture are:

Newton's Law and the Definition of Viscosity; Petroff's Law and the Calculation of Power Loss; General Discussion of the Coefficient of Friction; Principles of Thermal Equilibrium; Viscosity-Temperature Relations; Two Types of Viscous Flow; Work of Kingsbury, Sommerfeld and Michell; Dimensional Theory of Lubrication; Physical Properties of Lubricants; Friction Loss in High-Speed Bearings; Hydrostatic Lubrication; Hydrodynamic Lubrication; Forced Feed Lubrication; Thin Film Lubrication; Practical Definitions of Load Capacity; Determination of Loads on Bearings; Deformation and Vibration Effects; Lubrication of Dynamically Loaded Bearings; Present-Day Research Problems. The comments and discussions of other engineers are included; also a carefully prepared list of references.

Published February, 1949—Price $1.50*

PROCEEDINGS OF THE 20th NATIONAL OIL AND GAS POWER CONFERENCE, MAY 1948

In these proceedings are seven papers dealing with: improved techniques involved in applying the vectorscope to the study of firing orders; the characteristics of centrifugal blowers for two-cycle Diesel engines, and its advantage for certain applications; the existing numerical methods of solving torsional vibration problems, and how they can be understood by Holzer's principle; outstanding applications of Diesel engines in industrial and marine service; Diesel operation on inland waterways and on the rails.

Published February, 1949—Price $2.00*

THE FIRST FIFTY YEARS OF THE DIESEL ENGINE IN AMERICA

By Chas. E. Beck,
M. R. Bennett, R. L. Boyer
and C. G. A. Rosen

The four papers in this publication were presented at the 20th National Oil and Gas Power Conference, held at St. Louis, May 20–22, 1948.

The first article on historical development of the large modern Diesel in America, focuses attention on the accomplishments and achievements of companies and individuals who have had most to do with the developments leading up to the building and establishing of the large Diesel engine in America.

The second article is concerned with tracing the evolution of the high-speed Diesel engine in America from the inception of development work on relatively small high-speed engines to the present state of the art. Consideration is given to: Early developments, first automotive applications, the L-head Diesel engine, the Diesel crawler tractor, Diesels in automobiles and trucks, the small two-stroke cycle Diesel, and fuel injection, combustion, and starting systems in current use.

The third article on the present status of the large Diesel in America summarizes some of the important factors which have been responsible for progress in Diesel development. It also reviews all general prevailing views on overall designs, as well as some detail of designs.

The fourth article on the research development of the Diesel and newer reciprocating heat engines interprets Research achievements, and considers the following technical factors which have directed the trends in Diesel development: combustion phenomena; fuel injection equipment; improvements in air-charging of the cylinder; utilization of applied mechanics in the solution of vibration, stress and fatigue problems; lubricants and lubrication; improved materials; production techniques; and higher outputs.

**Published February, 1949—
Price $2.00***

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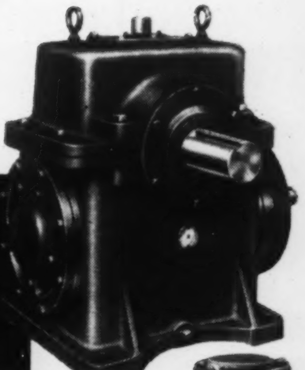
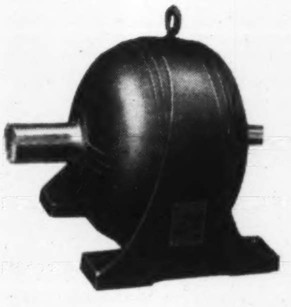
Foote Bros. Hypower Enclosed Worm Gear Drives assure economy in original cost and economy in operation. They bring a new compactness in design plus greatly increased thermal capacity. Available in vertical and horizontal types.





Foote Bros. Straight Line Enclosed Gear Drives will shortly be introduced. These compact units may be used with any standard motor. Ratios range from 5 to 240 to 1.

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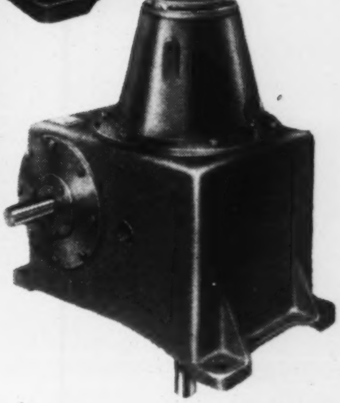

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If you require enclosed gear drives, the Foote Bros. line offers a wide variety of types, sizes and ratios to meet any need.

Nearly a century of engineering and manufacturing experience is back of Foote Bros. Drives. Two large plants contain the newest in gear generating equipment—new techniques in manufacture—better metallurgical control of materials—improved manufacturing methods—all assure you superior enclosed gear drives.

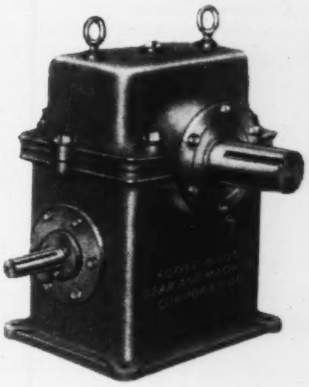
Mail the coupon for information.

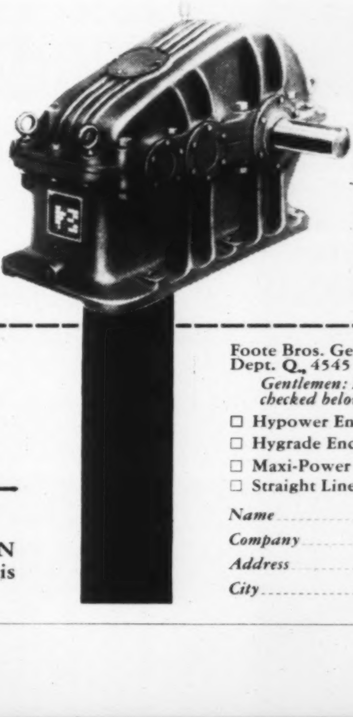
AVAILABLE FROM STOCK

A new policy of distribution now makes Foote Bros. Enclosed Worm Gear Drives available from stock. A range of sizes and ratios is offered to meet many industrial applications.

Foote Bros. Hytop Enclosed Worm Gear Drives provide wider low-speed bearing span. Ideal for installation where low-speed shaft extensions cannot be supported by pilot or guide bearings at the end of shaft. Available in both Hygrade and Hypower types.

Foote Bros. Hygrade Enclosed Worm Gear Drives have been newly engineered and now offer the maximum in rugged dependability. Specially designed for heavy-duty applications. Available in both horizontal and vertical types.





Foote Bros. Maxi-Power Helical Gear Drives are available in single, double and triple reductions. A newly engineered line that represents the last word in modern power transmission equipment.

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How to deal effectively with VIBRATION:

Locate it-
...with an MB PICKUP

VIBRATION PICKUP
TYPE 124
THE MB MFG. CO. INC.

Any trace of vibration comes to light when you attach this sensitive electrical pickup to your product. A rugged, precision-built product, it will withstand rough treatment.

When bolted to equipment under test, this velocity-type pickup faithfully converts vibratory motion to an electrical output. Signal can be visualized with an oscilloscope. Major industries today find it indispensable for accurate analyses. Write for bulletin 124.

……

Reproduce it-
...with an MB EXCITER

You can't beat this electro-dynamic exciter for shaking "bugs" out of products. With its frequency and force adjustments, you can "scan" a product for vibratory response—or fatigue-test it.

Take one case where a manufacturer of turbines was beset by blade failures. With an MB Exciter, he was able to resonate blades to destruction quickly—while studying their motions with stroboscopic light. In this way, he got to the cause of the trouble *visually!* More data in our bulletin 210B.

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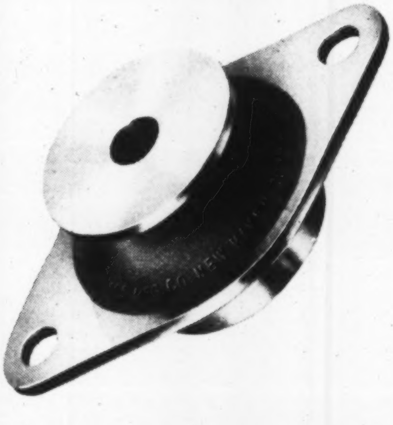
Isolate it-
...with ISOMODE* MOUNTS



Because Isomode mounts have equal spring rates in all directions, they're efficient at all angles — and they isolate all modes of motion!

That's why, by adopting Isomode units, one company was able to simplify suspension brackets and save on manufacturing costs in *addition to* improving vibration control! Another has been better able to cushion heavy duty engines—*without* redesigning the mounting system! Ask for bulletin 202 and Design Chart.

**Trade Mark Reg. U.S. Pat. Off.*

You can see why more and more engineers contact MB when they run into trouble with vibration. We'll be happy to cooperate with you on *your* problems. For more information and for bulletins on the above MB products, write to Dept. E4.

THE MB MANUFACTURING COMPANY, INC.
1060 State Street
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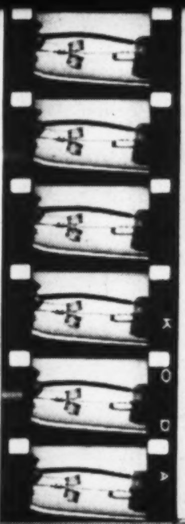
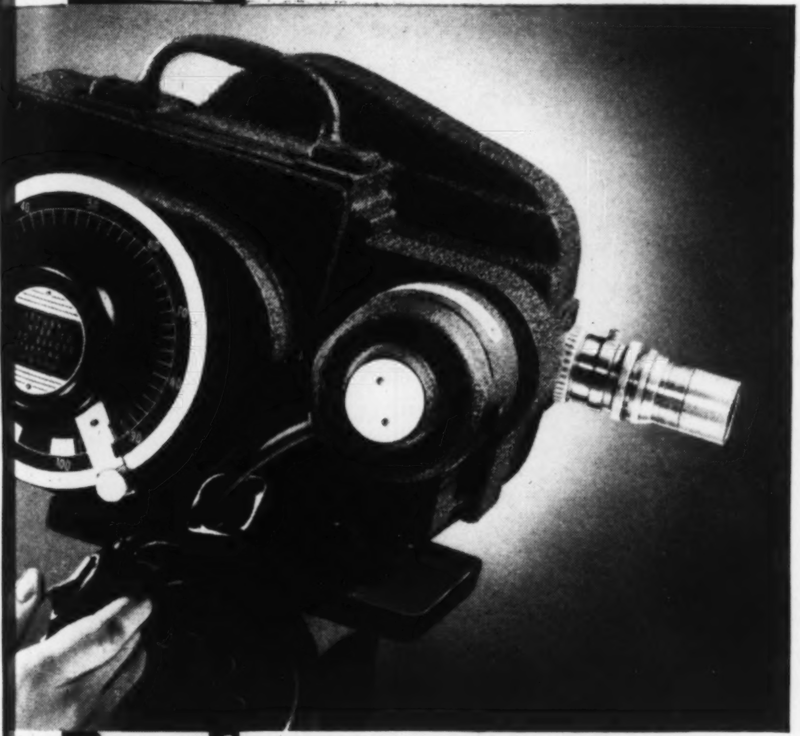
VIBRATION ISOLATOR UNITS • VIBRATION TEST EQUIPMENT

VIBRATION DIVISION



It can show you the heartbeat of a car radio—



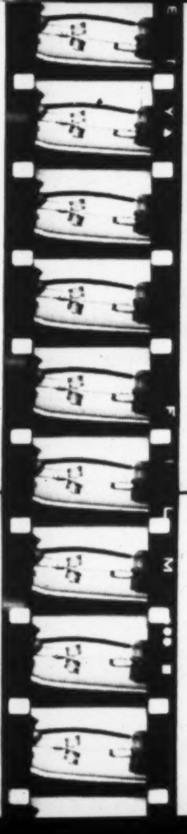
You could cover pages with calculations about a car radio vibrator. You could fill sheets with figures on inertia and elasticity of its vibrating elements—and yet not be sure exactly how the rapidly moving parts do behave in action.

This is where high speed movies come in—the kind of "slow motion" you get from the Kodak High Speed Camera. It's a simple, direct means to record and study high speed repetitive mechanical motion . . . the only way to see dynamically what happens in non-cyclic high speed action.

The Kodak High Speed Camera can take a second of action and spread it over three minutes. It can put flash marks along the side of the film that time the motion accurately. Its optical system gives the extra picture sharpness you need to see a vital point clearly.

This camera is a single unit with one motor, complete in itself and easy to operate. If you would like to know how it works and how it can help you, send the coupon.

EASTMAN KODAK COMPANY
Industrial Photographic Division
Rochester 4, N. Y.



the Kodak *High Speed* Camera

magnifying time
Kodak

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16

EASTMAN KODAK COMPANY
Rochester 4, N. Y.
Gentlemen:
Please send me: ☐ your folder "Magnifying Time" which tells about the Kodak High Speed Camera. ☐ a 16mm. sample reel of high speed motion study, which I may borrow.

Name________________ Firm________________

Address________________________________

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Kodak

How wrong can you get about the

Steel Scrap Shortage?

"SHORTAGE? *But the mills are running at capacity!*" True, but if they were melting more *heavy* steel scrap, they would be producing more steel from the same furnaces. It's the *heavy* scrap they lack, and that's the kind of scrap *you have*—the kind that makes better steel and, by processing faster, increases total production.

"SCRAP? *Sure, but we're already selling our scrap,*" Are you sure? Don't think of scrap as just the "left-overs" from fabrication. Scrap is any old piece of iron or steel that is not serving a useful purpose. The people who make steel or castings for you *can* find a purpose for it. See that they get it—through your scrap dealer.

"SCRAP? *There's enough overseas; let 'em have that!*" Some of this will be coming through, but not in good quantities until preparation and transportation facilities within those countries improve. Our critical scrap shortage can only be solved by U. S. manufacturers turning in their scrap and no-longer-needed equipment.

"SCRAP? *If I could get more steel, I'd have more scrap.*" That's right — as far as it goes. But it's also true that if the mills get more *heavy* scrap, there would be more steel on the market. So help out the condition by digging out the old un-used iron and steel accumulated in your plant. The more heavy scrap you and other people turn in, the more steel will be available.

"SCRAP? *We don't have any scrap in our business.*" You don't have to be a metalworking plant to have badly-needed iron and steel scrap. Practically every manufacturing plant today is a virtual treasure-house of iron and steel machinery and equipment that has out-lived its usefulness. This is the so-called "heavy" scrap that makes the best steel and castings—and faster.

A PUBLIC SERVICE PROJECT
THE ADVERTISING COUNCIL

SCRAPPY SAYS:

Search your plant for HEAVY SCRAP ...Help make MORE STEEL!

Set up a steel scrap salvage program in your plant — NOW

Space contributed by

MECHANICAL ENGINEERING

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with FAFNIR'S
new line of
heavy duty

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Type LAO

Incorporates the Fafnir Wide Inner Ring Ball Bearing with the exclusive self-locking collar . . . PLUS Mechani-Seals

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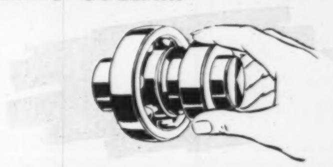
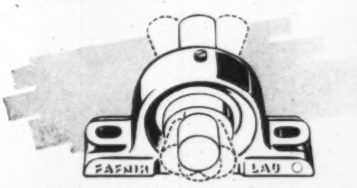
COMPACT, STREAMLINED DESIGN.

One-piece housing, reinforced at stress points for extra strength. Can be mounted in any position.

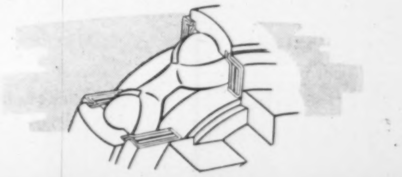
HEAVY SERIES FAFNIR WIDE INNER RING BALL BEARING WITH SELF-LOCKING COLLAR.



UNRESTRICTED SELF-ALIGNMENT IN ALL DIRECTIONS



MECHANI-SEALS PLUS integral synthetic rubber and felt washer. External slinger throws off contaminants.



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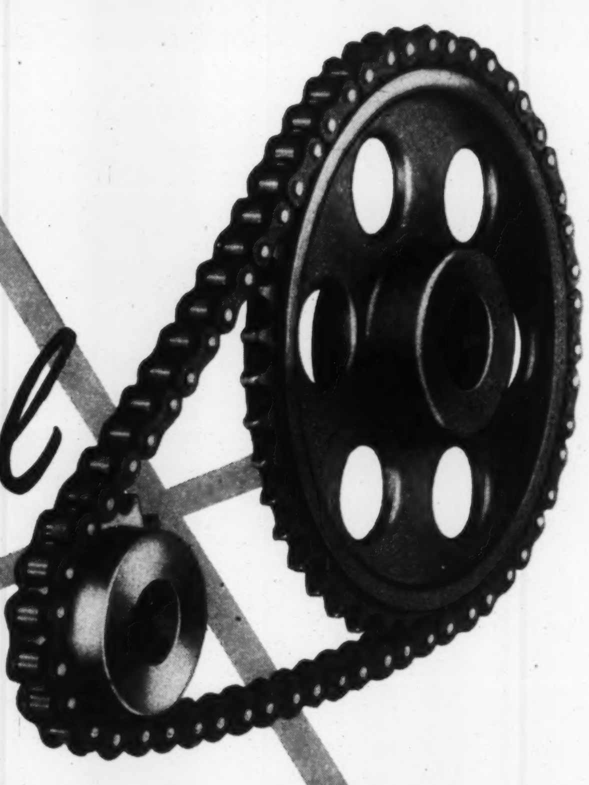


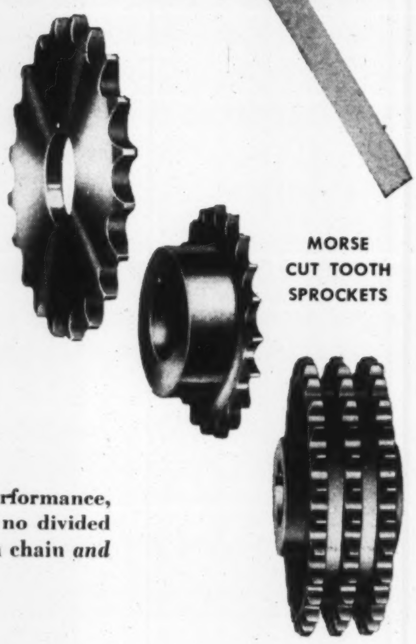
MORSE ROLLER CHAIN DRIVES

MORSE ROLLER CHAIN, made in American manufacturers' standard sizes, to standard dimensions as approved by the A.S.M.E and A.G.M.A., is *more* than standard in performance.

Its extra ruggedness, high efficiency, and dependable service have stamped it in the minds of designers and engineers as extra special for better mechanical power transmission.

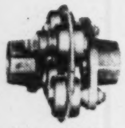
Available in single and multiple widths, with pitches from 3/8″ to 2½″. Morse Roller Chain represents the result of engineering skill applied to a practical knowledge of chain design.

You get low-cost, positive, efficient, flexible chain drives for your mechanical power transmission with Morse Roller Chain. For complete information, write Dept. 354, Morse Chain Company, Detroit 8, Mich.



MORSE CUT TOOTH SPROCKETS

Morse Cut Tooth Sprockets, accurately machined for top performance, are recommended for use with Morse Roller Chain. There's no divided responsibility for chain drive performance when you get both chain *and* sprockets from Morse.



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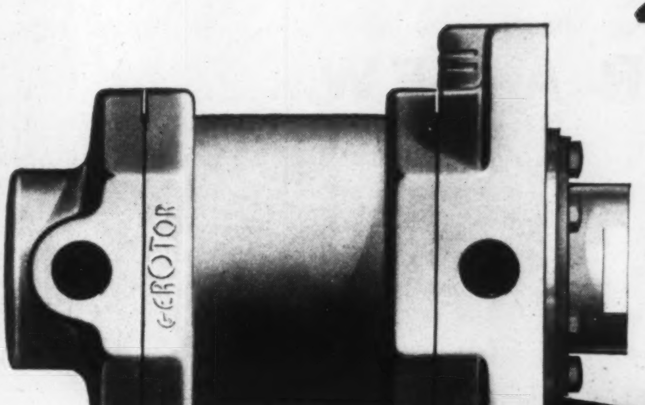
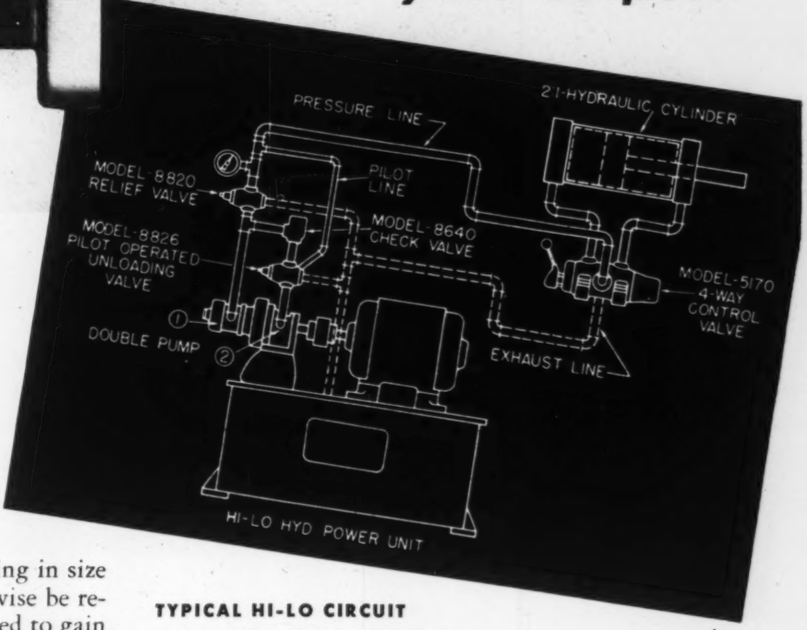


Double the Rod Size —

and increase your output!



TYPICAL HI-LO CIRCUIT FOR HYDRAULIC PRESSES

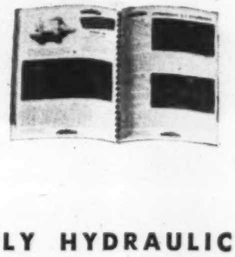
GEROTOR 1500 P.S.I. HYDRAULIC 2:1 CYLINDERS have a piston rod about twice as large as standard cylinder rod size. The larger rod reduces oil displacement, permitting it to retract at twice the speed that it extends. This speed-up shortens cycle time, allowing the rod to extend again quickly, thereby accomplishing more work!

This faster speed is gained with a saving in size of motor and pump which would otherwise be required. 2:1 cylinders may also be employed to gain identical retracting and extending speeds, as well as to support larger loads where straight linear motion is used.

Available in 6 standard mountings: Foot, Trunnion, Center Line, Blind End Flange, Rod End Flange, and Clevis; in 10 bore diameters; in any stroke up to 96″; and with cushioning.

Remember—Gerotor Hydraulic Cylinders have Keeper ring design, permitting the cylinder to be rotated to convenient pipe connection.

Send for Catalog Section No. 103 illustrating and describing all types and sizes of Gerotor Hydraulic Cylinders.



This circuit illustrates a press application where rapid speed and low pressures are required for the major portion of the stroke and high pressures are required for the "squeeze" portion of the stroke. The output of both the low pressure high volume pump (2) and the high pressure small volume pump (1) is directed to the hydraulic cylinder at a low operating pressure. When sufficient work load builds up, pressure in the system increases and the model 8826 pilot operated unloading valve unloads the output of pump (2) while the output of pump (1) is still directed to the cylinder. Direction of piston travel is controlled by model 5170 4-Way control valve. The horsepower requirement for this type of circuit is much less than if a single pump of sufficient volume and pressure for the application were used.

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AIR AND HYDRAULIC VALVES AND CYLINDERS, HYDRAULIC PUMPS, MOTORS AND PUMP UNITS

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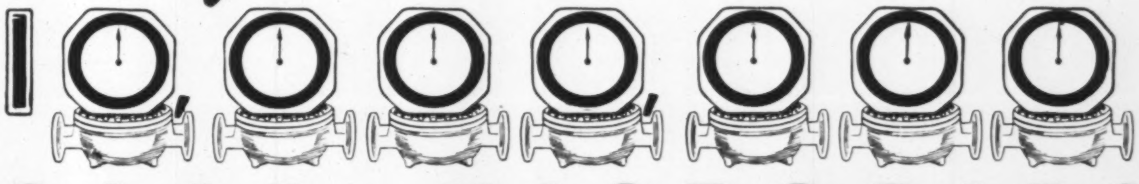

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FORM 566-4

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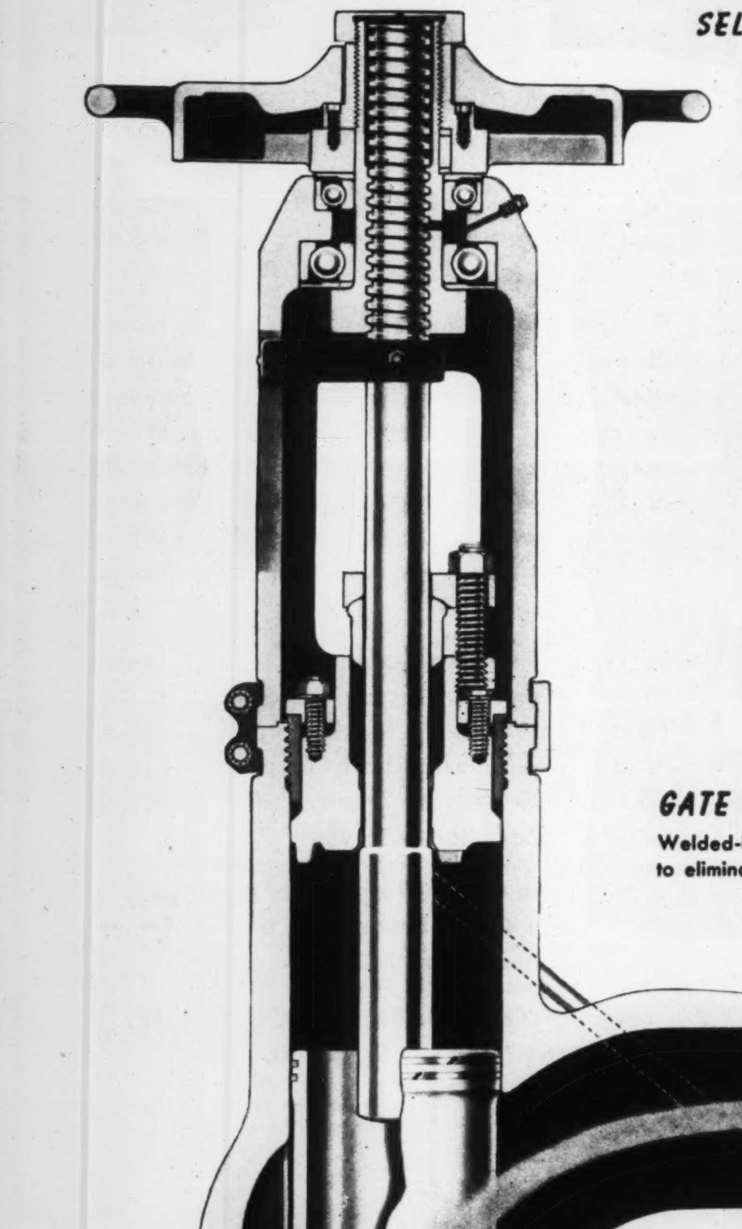

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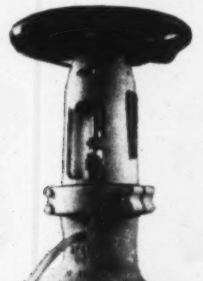
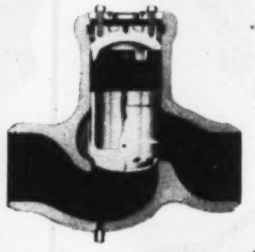


Now you can get Edward pressure-seal bon net valves in gate, globe or angle pattern for stop, check or non-return service. Ne features for lower and lower pressure dro have been built in—and **proved.** On no othe valve series is there more proven flow data

EDWARD PATENTED EVALTHRUST YOKE* BUSHIN

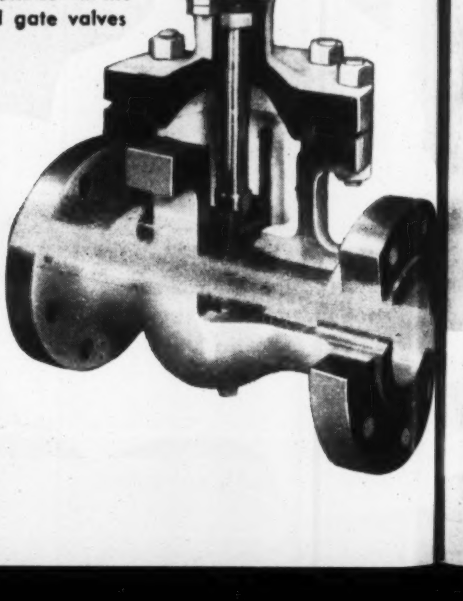
and Impactor handwheel for easiest closin in cramped locations is standard on stop an non-return series. So is closure indicator.



ON CHECK VALVE, left, and non-retur valve, far left, note new enclosed dash-po disk, Edward Equalizer for high disk lift an free flow passage. The whole series is reg ularly built in chrome-moly steels for stabilit at high temperatures.

GATE VALVE THAT STAYS TIGHT

Welded-in Stellited seats, welded-in guide ribs to eliminate wedge drag on seating faces, ball bearing operation clear down to 4 or 5 in. sizes—these and many other features are standard—not added cost extras—in the new Edward gate valves



WANT MORE DATA? Special bulletins are now available on most of these designs. A few are so new that full catalog data isn't ready yet, but we can supply dimensional drawings. Ask your nearest Edward representative, or write direct to Edward Valves, Inc., East Chicago, Indiana.

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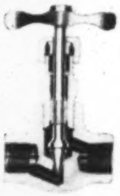
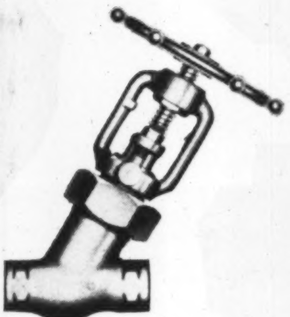
A WHOLE NEW GROUP f Edward Steel Valve Designs

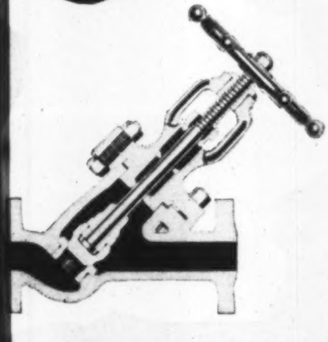
NEW GAGE VALVES.. NEW WELDED BONNET UNIVALVES.. NEW BLOW-OFF VALVES... NEW GATE VALVES



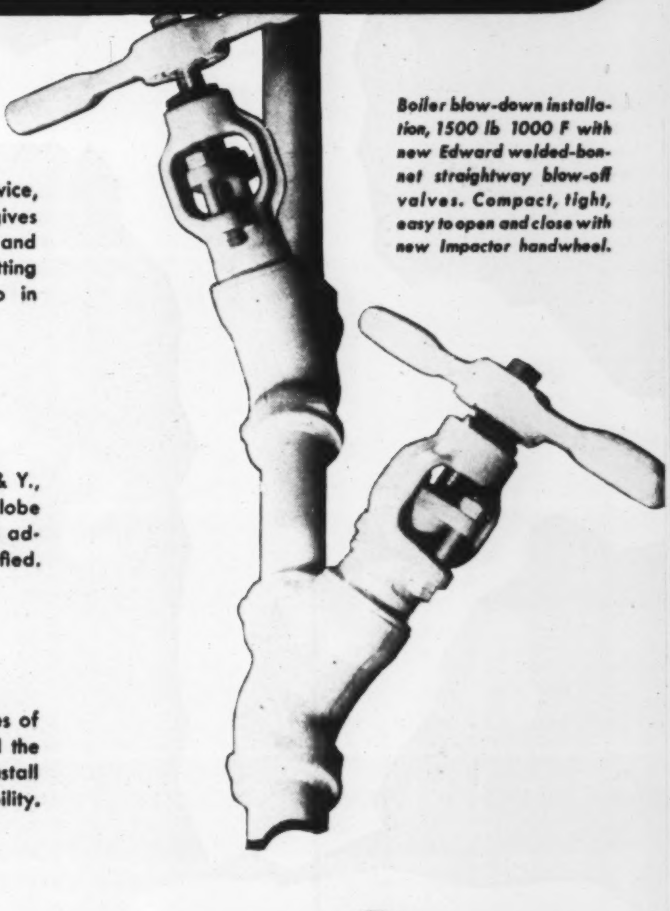
FINE REGULATION ON GAGE LINES For gage and meter service, the redesigned Edward Fig. 152 valve gives close flow regulation with small seat port and longer seat-stem contact area. New form fitting T-Handle. Rated 4000 lb W.O.G. Also in 12% Cr. and 18-8 stainless steels.



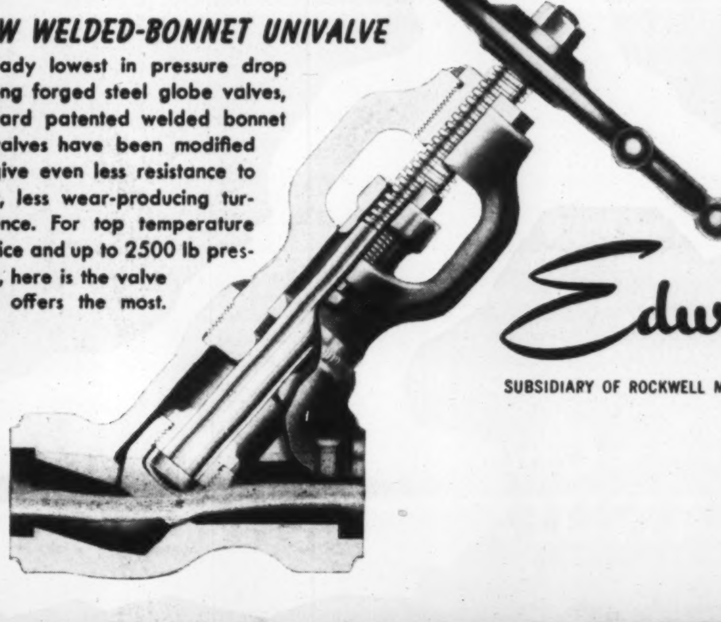
ALL-PURPOSE SMALL GLOBE VALVE Here's a new O. S. & Y., union bonnet, bolted gland forged steel globe valve for a multitude of services. Packing adjustment or replacement greatly simplified. Rated 800 lb, 750 F.



BLOW-OFF FLEXIBILITY A new series of 300 lb O. S. & Y. blow-off valves with all the design features of high pressure valves. Install them in any position for greatest piping flexibility.



Boiler blow-down installation, 1500 lb 1000 F with new Edward welded-bonnet straightway blow-off valves. Compact, tight, easy to open and close with new Impactor handwheel.



NEW WELDED-BONNET UNIVALVE Already lowest in pressure drop among forged steel globe valves, Edward patented welded bonnet Univalves have been modified to give even less resistance to flow, less wear-producing turbulence. For top temperature service and up to 2500 lb pressure, here is the valve that offers the most.

NEW, EASIER CLOSING Now the Edward Impactor handwheel, modernized and improved, is available on many small valves as well as large. Easy-to-grip cross bar delivers 2.8 times the closing load of ordinary handwheels. No wrenches or extension bars needed.

Edward Valves, Inc.

SUBSIDIARY OF ROCKWELL MANUFACTURING CO. EAST CHICAGO, INDIANA

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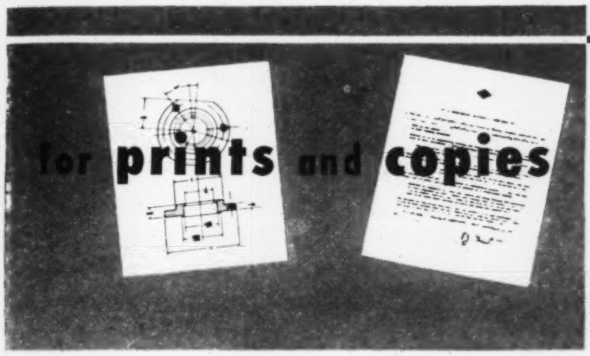

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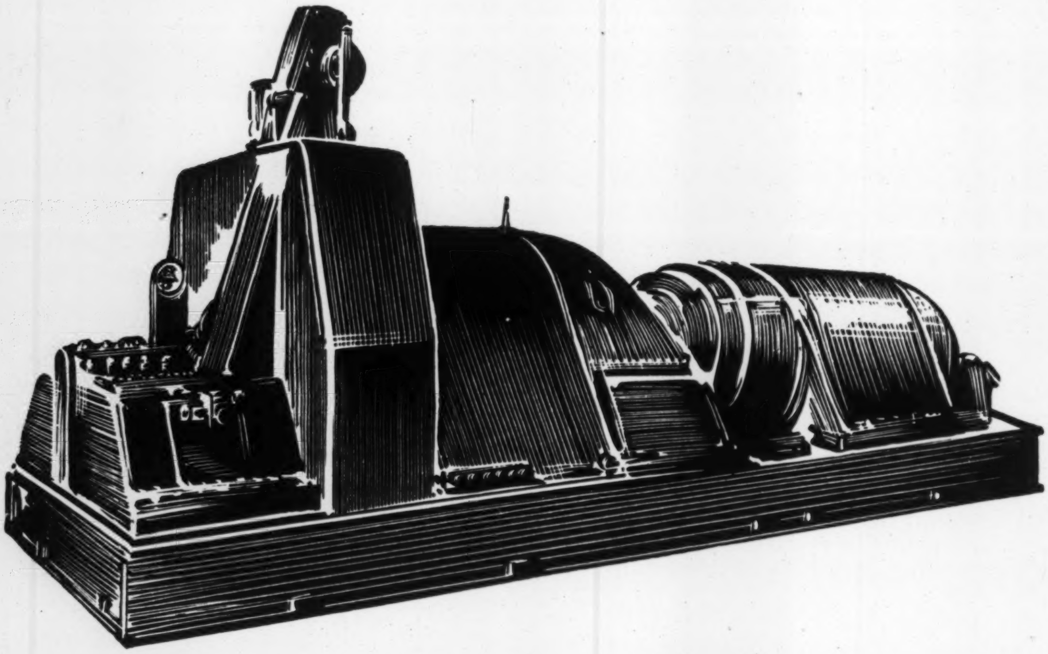

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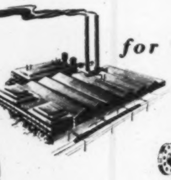

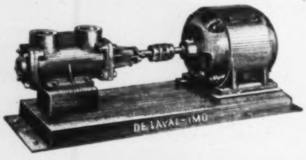

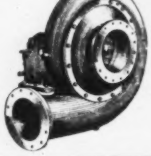

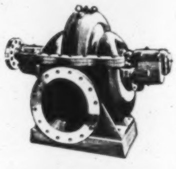

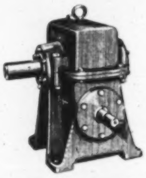

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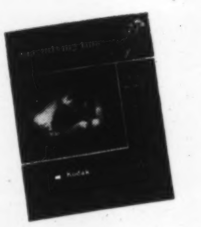

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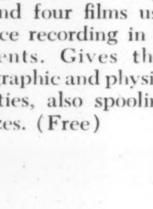

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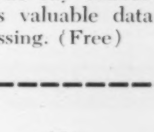

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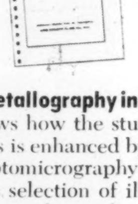

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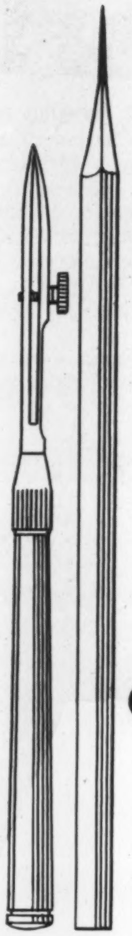

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TITUS STATION

METROPOLITAN EDISON COMPANY

THE C-E Unit illustrated here is one of two such units now in process of fabrication for the Titus Station of the Metropolitan Edison Company at Reading, Pennsylvania.

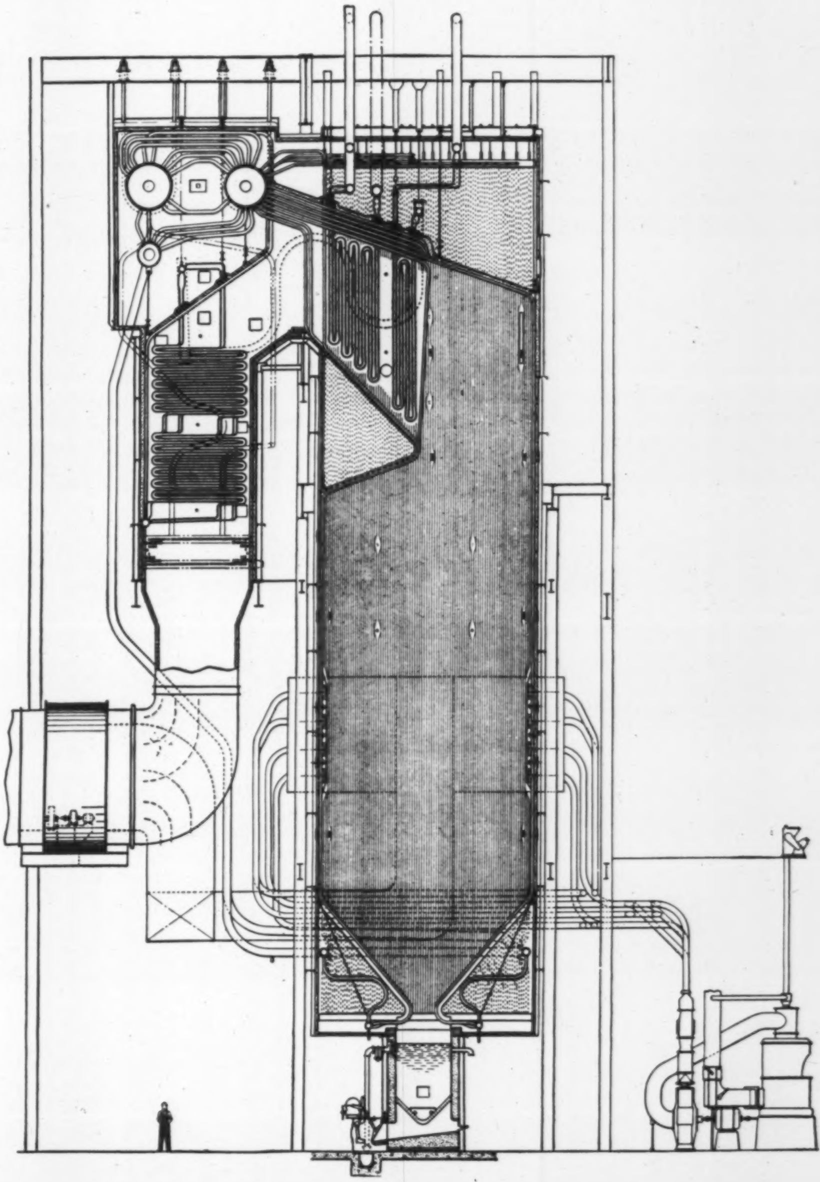
Each of these units is designed to produce 510,000 lb of steam per hr at 1475 psi and 1010 F. The design contemplates that about 90 per cent of this capacity — 465,000 lb — can be returned to the reheat section at 710 F to be reheated to 1010 F.

The units are of the radiant type with a reheater section located between two stages of the primary superheater surface. A finned tube economizer is located below the rear superheater section, and regenerative air heaters follow the economizer surface.

The furnaces are fully water cooled, using closely spaced plain tubes throughout. They are of the basket-bottom type, discharging to sluicing ash hoppers.

Pulverized coal firing is employed, using bowl mills and vertically-adjustable, tangential burners. Arrangements are provided for the use of oil as an alternate fuel when and if required.

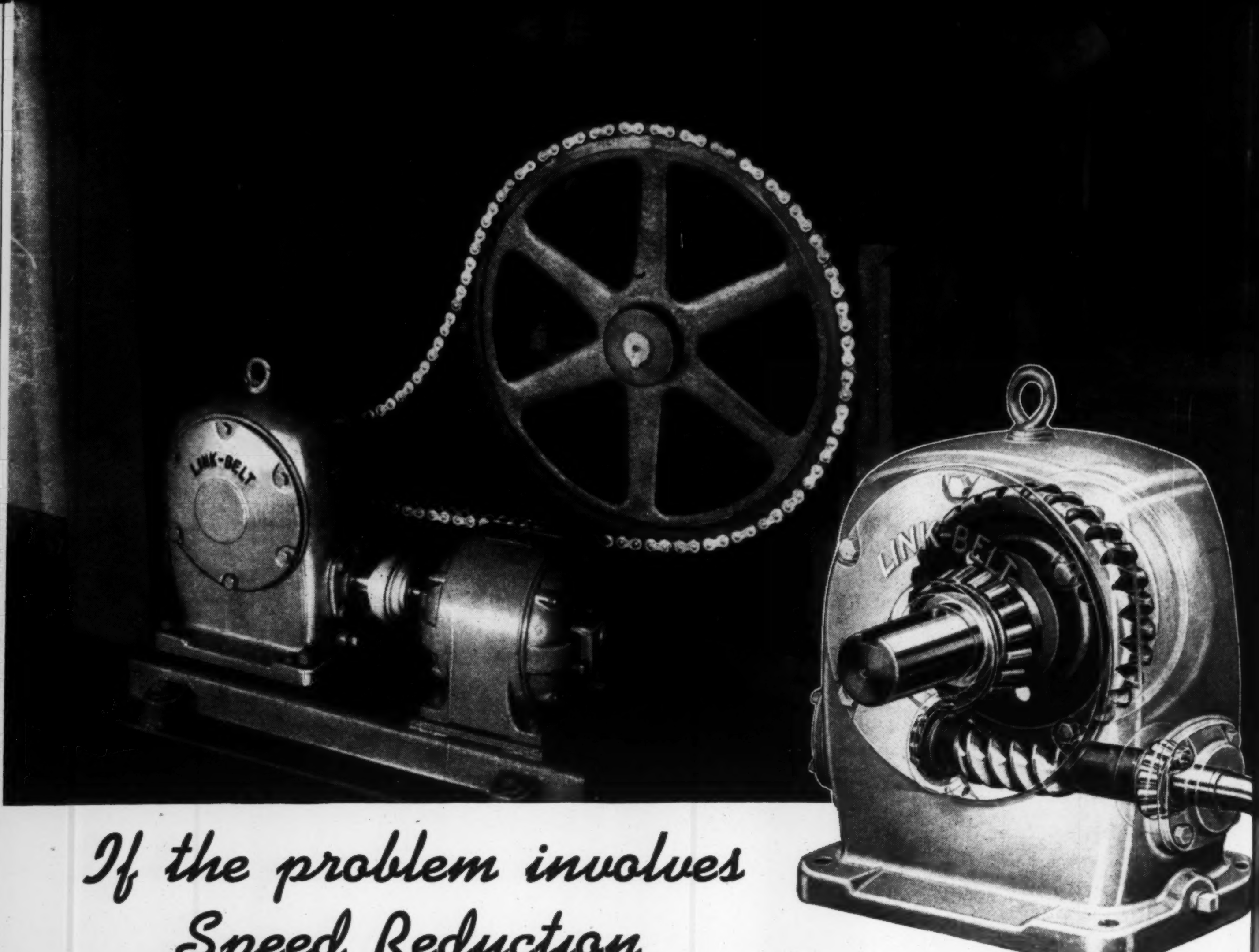
B-298



C-E

Combustion Engineering–Superheater, Inc.

A Merger of COMBUSTION ENGINEERING COMPANY, INC. and THE SUPERHEATER COMPANY
200 MADISON AVENUE, NEW YORK 16, N. Y.



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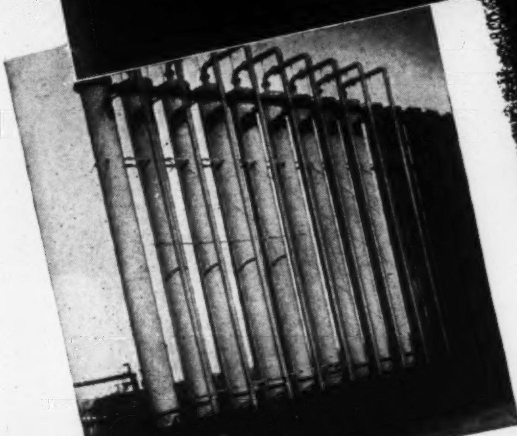

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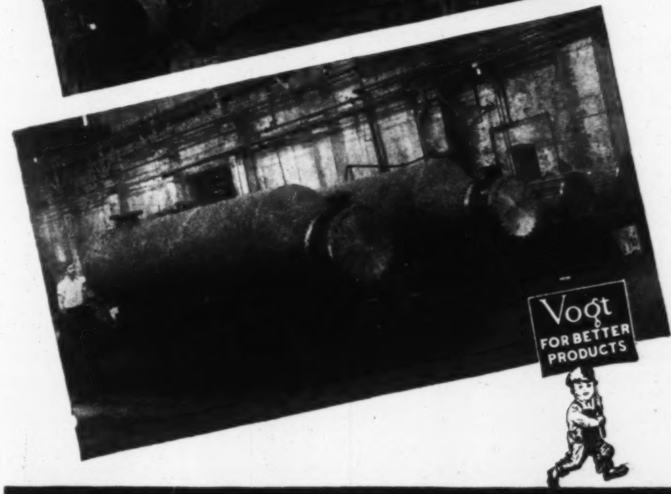

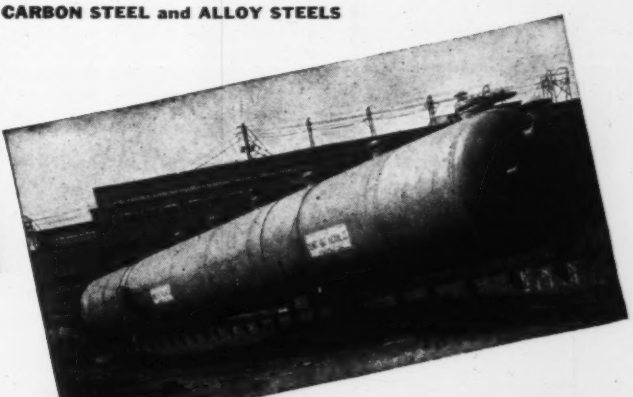

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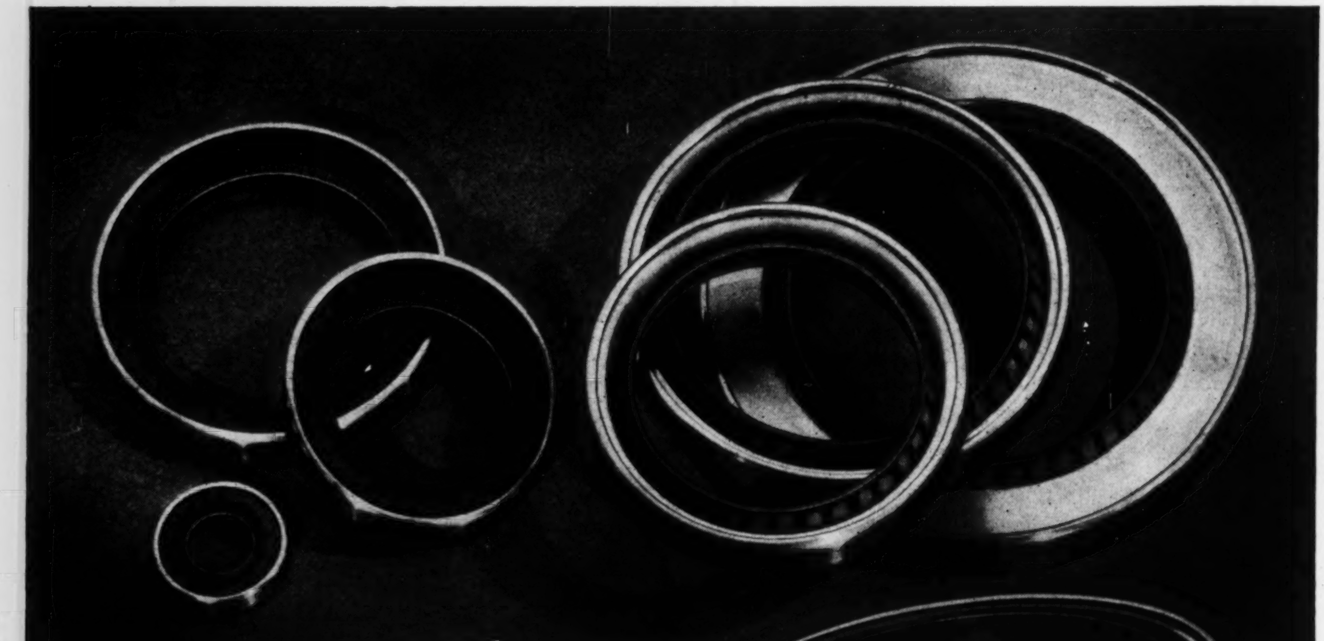

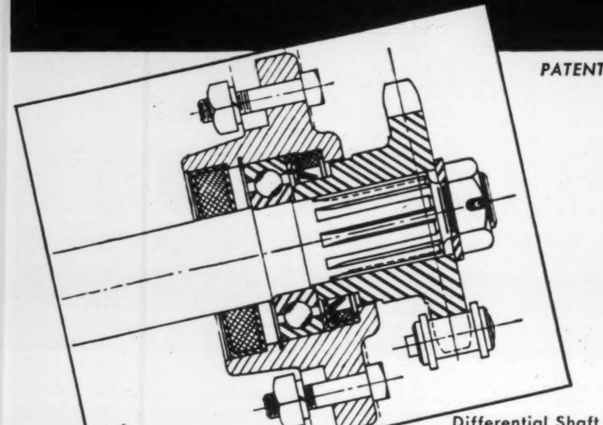

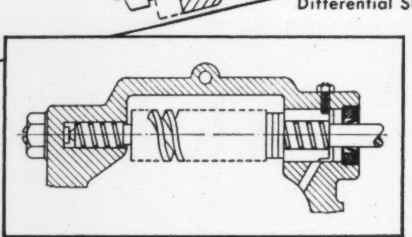

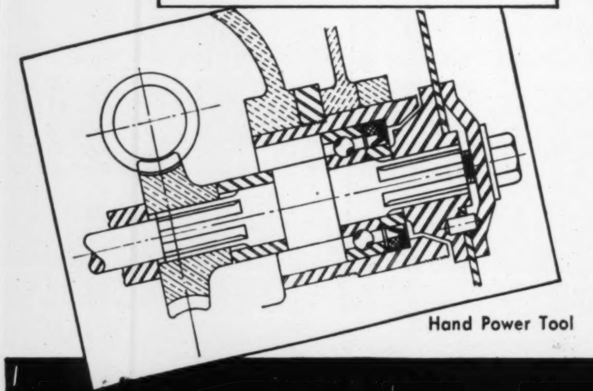

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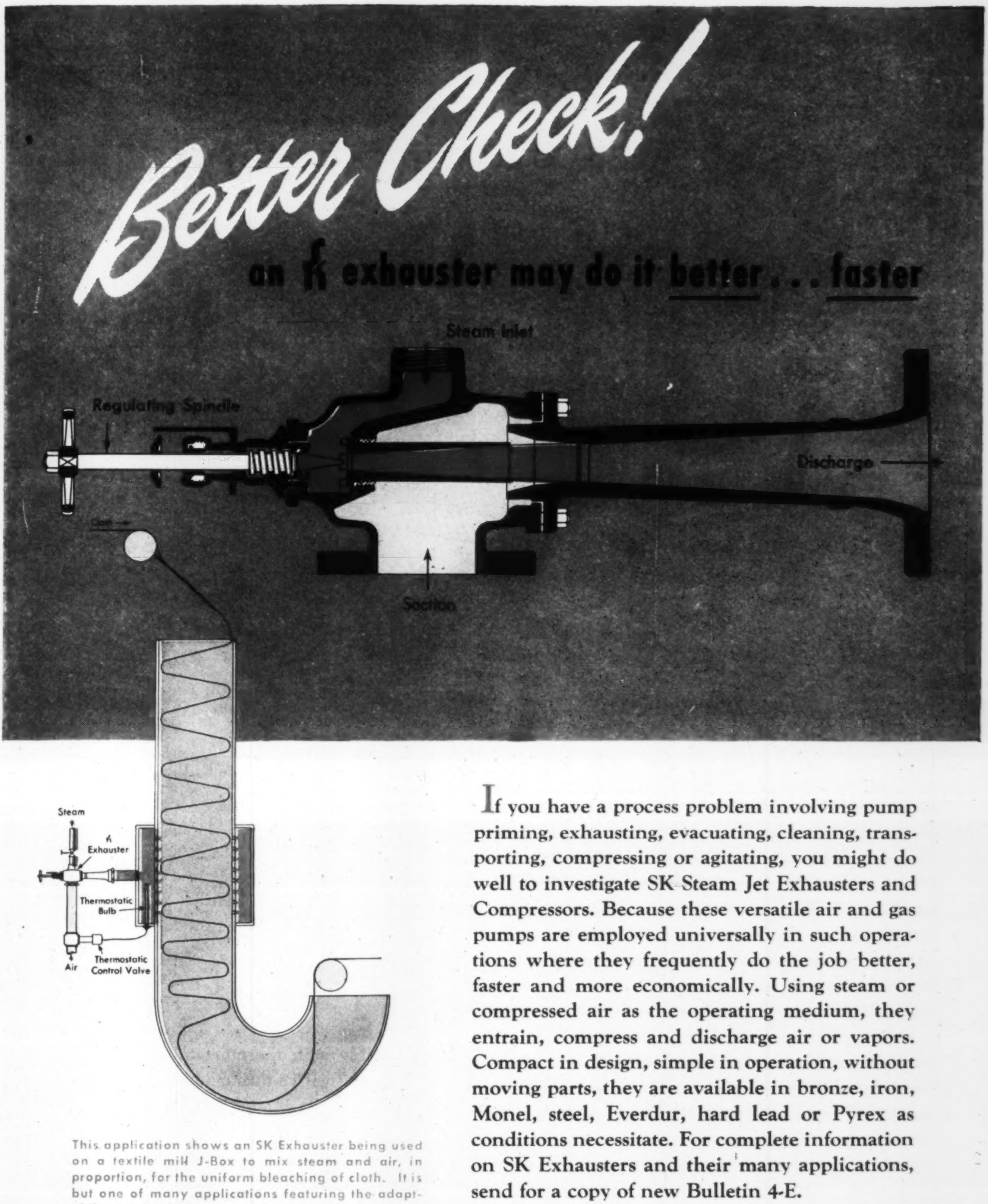
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an SK exhauster may do it better . . . faster
Steam Inlet
Regulating Spindle
Discharge
Suction
Cloth
Steam
SK Exhauster
Thermostatic Bulb
Air
Thermostatic Control Valve

This application shows an SK Exhauster being used on a textile mill J-Box to mix steam and air, in proportion, for the uniform bleaching of cloth. It is but one of many applications featuring the adaptability of the Jet.

If you have a process problem involving pump priming, exhausting, evacuating, cleaning, transporting, compressing or agitating, you might do well to investigate SK Steam Jet Exhausters and Compressors. Because these versatile air and gas pumps are employed universally in such operations where they frequently do the job better, faster and more economically. Using steam or compressed air as the operating medium, they entrain, compress and discharge air or vapors. Compact in design, simple in operation, without moving parts, they are available in bronze, iron, Monel, steel, Everdur, hard lead or Pyrex as conditions necessitate. For complete information on SK Exhausters and their many applications, send for a copy of new Bulletin 4-E.

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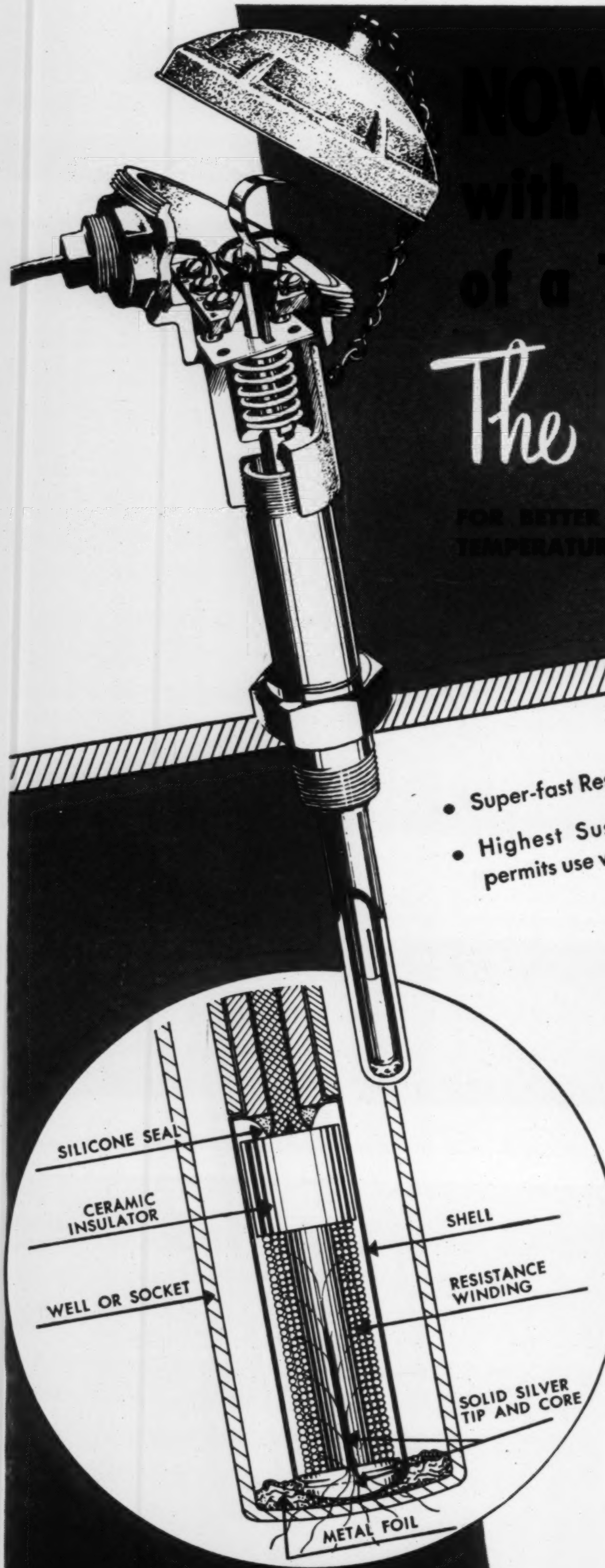

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The new Dynatherm Resistance Bulb, with its super-fast end-contact, combines the advantages of both thermocouple and resistance type temperature measurement in ranges up to 600°F.

For the first time, it is now possible to benefit from the inherent accuracy and stability of a resistance bulb, without premium cost or the need for special wells or sockets.

The Dynatherm offers higher sustained accuracy than thermocouples. It eliminates need for cold junction compensation . . . gives stability in measurement impossible with thermocouples. This resistance bulb is so sensitive throughout its entire range that full accuracy is maintained even on narrow scales, and its speed, when used in a socket, is equal or superior to that of a thermocouple similarly protected. Write for full details. **The Foxboro Co., 182 Neponset Avenue, Foxboro, Mass., U. S. A.**

FOXBORO INSTRUMENTATION

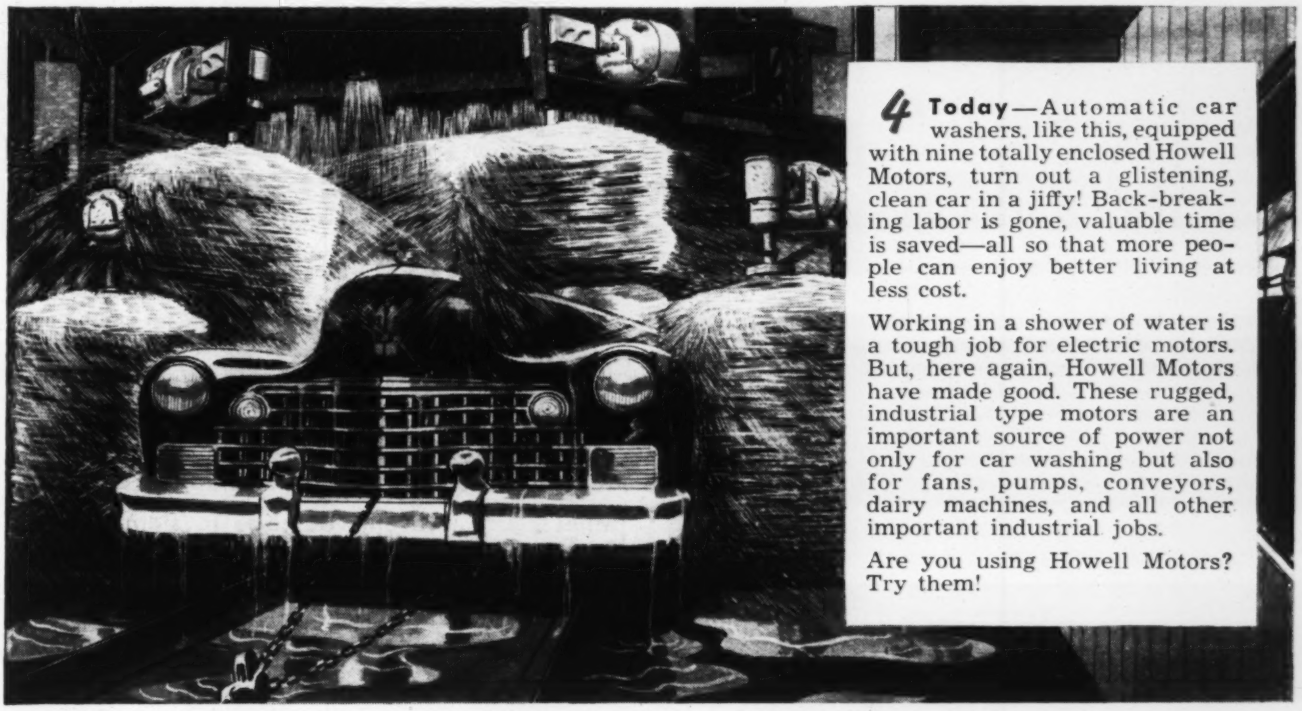
REG U S PAT OFF

1 **1897**—America's first cars, hand-built and expensive, looked like this. Big questions of the day were—will it run? can I ever afford to buy one? Little thought was given to washing a car.

2 **1915**—Howell "Red Band" Motors arrived. The electrical horsepower age was already under way. Automobiles, as well as other goods and services, were soon to be better, cheaper.

3 **1935**—This combination brush and spray was one of many early car-washing devices. It wasn't until 1945 that modern assembly line methods began to be applied to the washing of cars.

NOW, A WASH WHILE YOU WAIT!



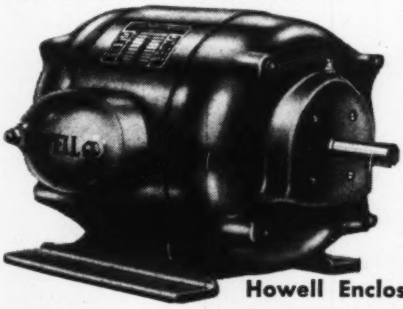
4 **Today**—Automatic car washers, like this, equipped with nine totally enclosed Howell Motors, turn out a glistening, clean car in a jiffy! Back-breaking labor is gone, valuable time is saved—all so that more people can enjoy better living at less cost.

Working in a shower of water is a tough job for electric motors. But, here again, Howell Motors have made good. These rugged, industrial type motors are an important source of power not only for car washing but also for fans, pumps, conveyors, dairy machines, and all other important industrial jobs.

Are you using Howell Motors? Try them!

Free enterprise encourages mass production, supplies more jobs—provides more goods for more people at less cost.

Howell totally enclosed motor built for operation in high humidity atmosphere. Remember, there's a Howell Motor for *every* industrial job.

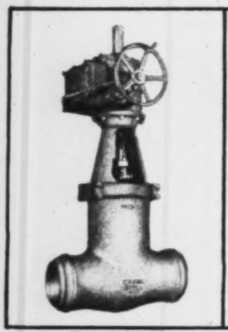


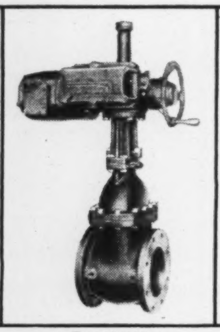
Howell Enclosed or Splash-Proof Motor

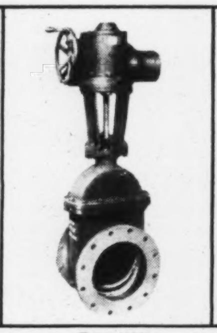
HOWELL MOTORS

HOWELL ELECTRIC MOTORS CO., HOWELL, MICH.
Manufacturers of Quality Industrial Type Motors Since 1915

HOWELL
Red Band
MOTORS

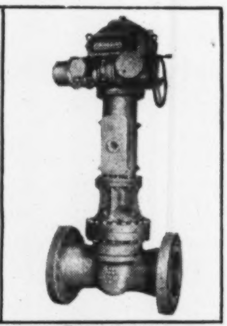

Type "S"
LimiTorque
on Crane Pressure-Seal Valve


Type "M"
LimiTorque
on Jenkins Gate Valve


Type "S"
LimiTorque
on Darling Gate Valve

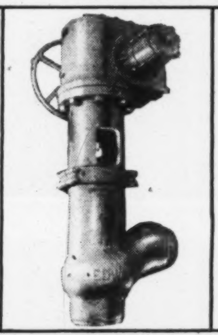
Type "SM"
LimiTorque
on Ludlow Gate Valve

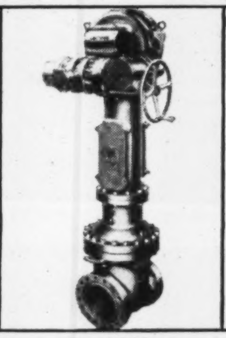
Type "SM"
LimiTorque
on American Chain & Cable Co. (RP&C) Gate Valve

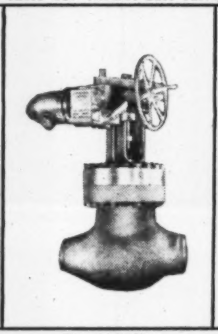

Type "SC"
LimiTorque
on Crane Venturi Gate Valve

Type "SM"
LimiTorque
on Schutte & Koerting Reducing Valve

Type "SM"
LimiTorque
on Rennselaer Inside Screw Gate Valve


Type "S"
LimiTorque
on Edward Angle Valve


Type "SC"
LimiTorque
on Powell Gate Valve


Type "GS"
LimiTorque
on Edward Boiler Non-Return Valve

Type "BFM"
LimiTorque
on Phillips (Henry Pratt Co.) Butterfly Valve

Types "S" & "M"
LimiTorque
on R-S Butterfly Valve (in tandem operation)

Type "SM" **LimiTorque** on Chapman 30" & 36" Gate Valves

Type "M" **LimiTorque** on 24" Iowa Gate Valve

Type "S"
LimiTorque
on Walworth Valve

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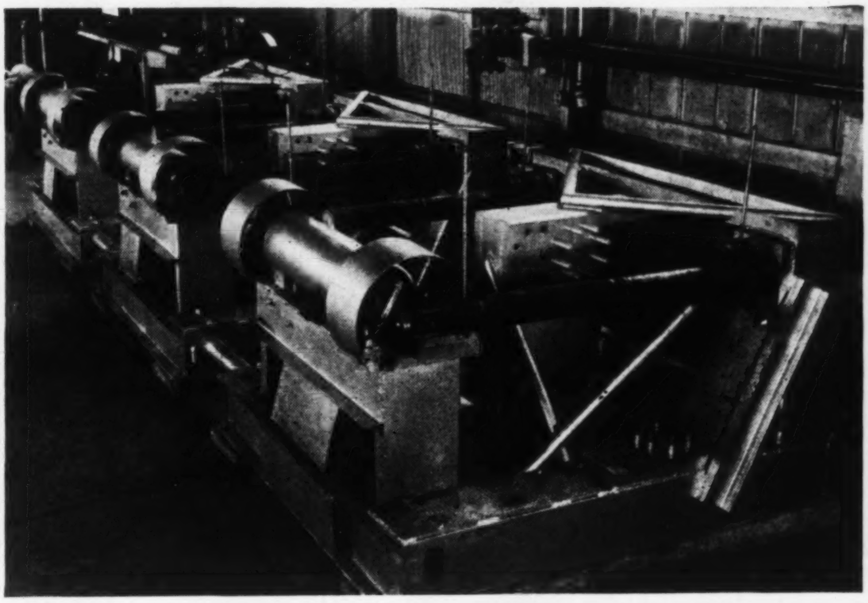

Strength through Design in Tube-Turn welding flanges

Taking the measure of piping fatigue

PIPE lines are *live, dynamic* members of a piping system. They *breathe* with changes in temperature and pressure. And the danger of fatigue failure from pressure shock, thermal shock, and cyclic conditions is ever-present.

More precise information was needed on this subject. So, Tube Turns research engineers set out to get the answers. For the purpose, they designed and built a unique cyclic testing machine to handle full-size piping assemblies under a wide range of temperature, pressure, and corrosive conditions. And on this torture rack they subjected flanged assemblies to reverse bending tests carried on to ultimate failure. Information revealed forms the basis of new designs for greater strength in Tube-Turn welding flanges.

Other piping assemblies, too—welding elbows, mitre bends, manufactured and fabricated tees, pipe bends—have been subjected to punishment more severe than any they would probably face in normal service. And this perpetual search for greater strength through better design has paid off in the form of realistic, non-theoretical facts providing a sound basis for Tube Turns' manufacturing policies—facts important to anyone interested in getting his money's worth in long life from piping installations.

Tube Turns' research and development organization, finest in the welding fittings industry, is constantly striving for the improvement of present products, the development of new ones. Notable among their recent achievements have been the design of a new type welding tee and the development of aluminum welding flanges.

Ask to be put on the mailing list for Tube Turns' technical periodical, *Piping Engineering*. Paper 6.01, for instance, deals extensively with standard steel flanges. Others give you research findings and additional working information pertaining to piping not generally available in convenient form.

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TUBE TURNS, INC.

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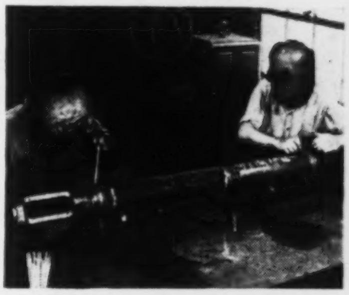
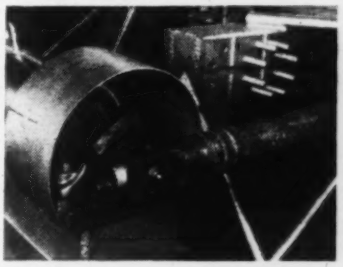
District Offices at New York, Philadelphia, Pittsburgh, Chicago, Houston, Tulsa, San Francisco, Los Angeles

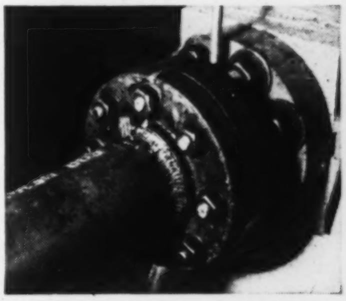
TYPICAL FLANGE ASSEMBLY TESTS



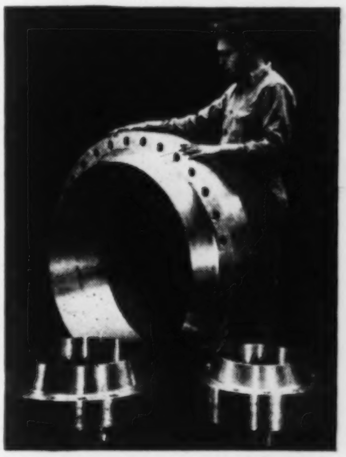
Assemblies were of 4-inch nominal size with 300 pound forged steel flanges and standard weight pipe.



Eccentric crank arm produces up-and-down movement which creates a cyclic bending moment on flange or fitting at opposite end of assembly.



Water spurts from crack in test specimen. Almost invariably, failure occurred in the pipe adjacent to the flange.



Aluminum welding flanges . . . another Tube Turns first! Available in a wide range of types and sizes.

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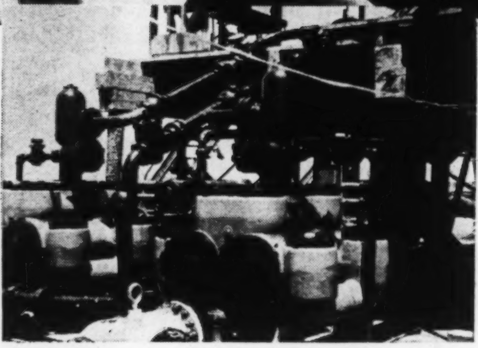
USE **BARCO** JOINTS TO KEEP PRESSURE LINES *FLEXIBLE*...

Barco Flexible Joints provide for expansion and contraction, keep pipes aligned, protect fluid-conveying systems throughout transportation and industry against interruptions or breakdowns. For over 40 years Barco has provided responsive, compensating movement through every angle. Today, there is a Barco Flexible Joint for every need. For more details, write Barco Manufacturing Company, 1807 Winnemac Avenue, Chicago 40, Illinois. In Canada: The Holden Co., Ltd., Montreal, Canada.



BARCO JOINTS ON A MUD PUMP FOR THE OIL FIELDS

This is one of the many applications using Barco Flexible Joints where a flexible conveyor is required for oil, steam, air, gasoline, tar, water and other fluids. You will find Barco Joints in oil refineries, steel mills, shipyards, working on a wide variety of machines.

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Not just a swivel joint ...but a combination of a swivel and ball joint with rotary motion and responsive movement through every angle.

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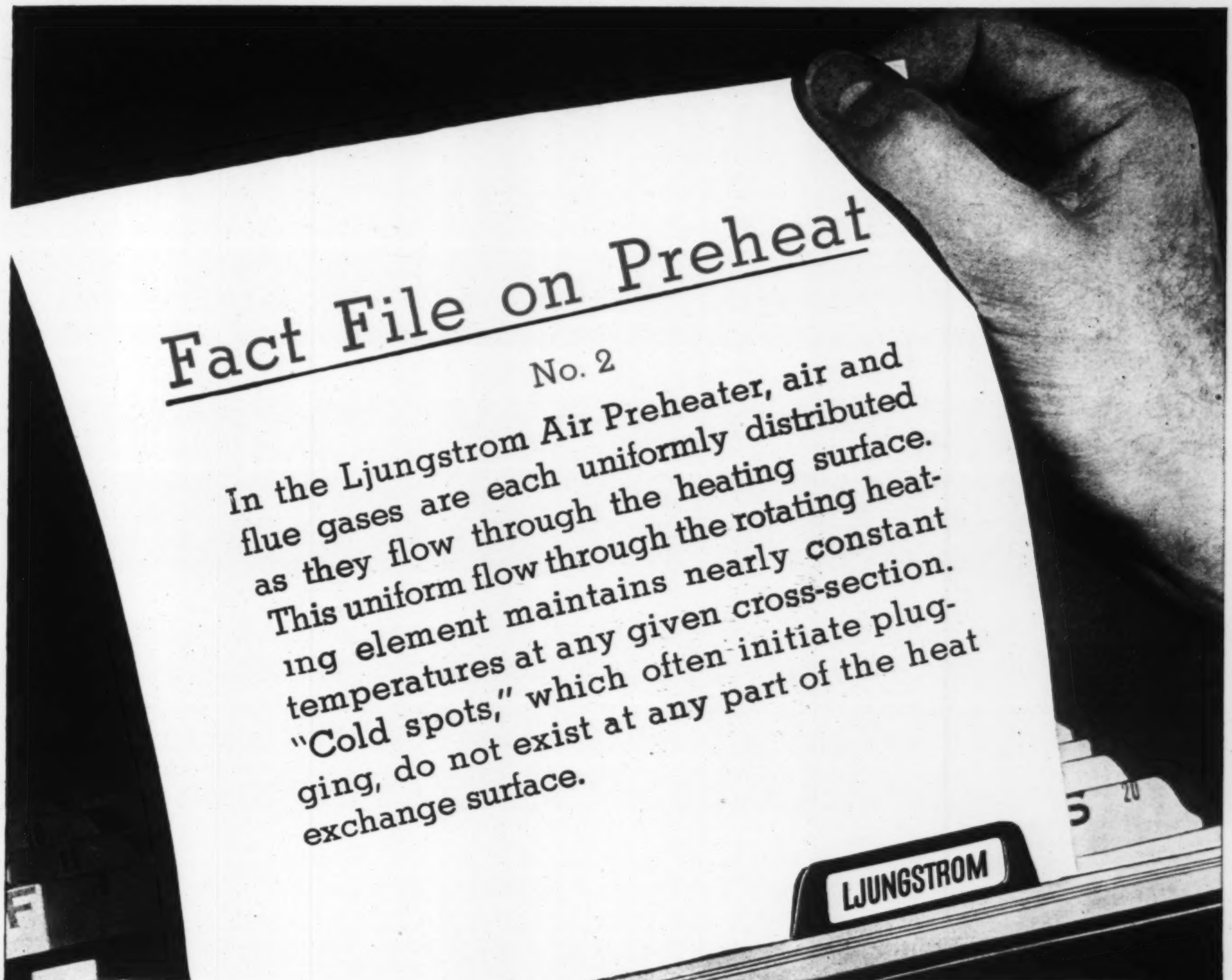
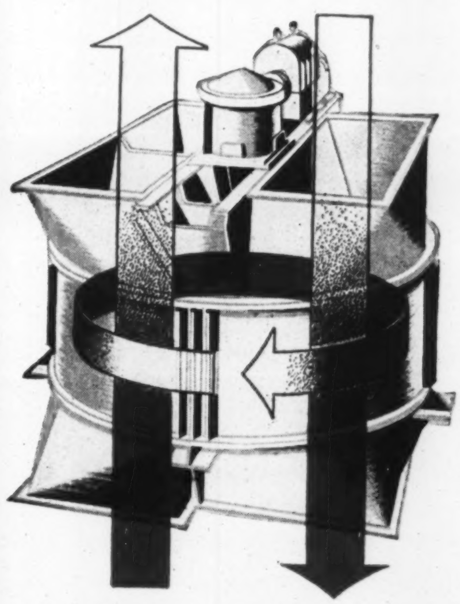
"MOVE IN EVERY DIRECTION"


Fact File on Preheat

No. 2

In the Ljungstrom Air Preheater, air and flue gases are each uniformly distributed as they flow through the heating surface. This uniform flow through the rotating heating element maintains nearly constant temperatures at any given cross-section. "Cold spots," which often initiate plugging, do not exist at any part of the heat exchange surface.



The Ljungstrom Air Preheater is a compact gas-to-air or gas-to-gas heat exchanger, operating on a continuous regenerative counterflow basis. Hundreds of power plants and other special applications confirm its high level of heat recovery and long-term service at low maintenance expense.

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AIR PREHEATER
CORPORATION
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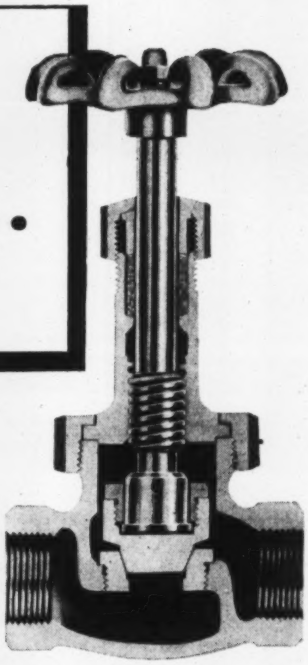
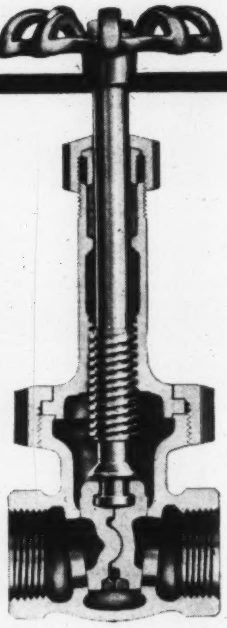
Plant: Wellsville, N. Y.
960

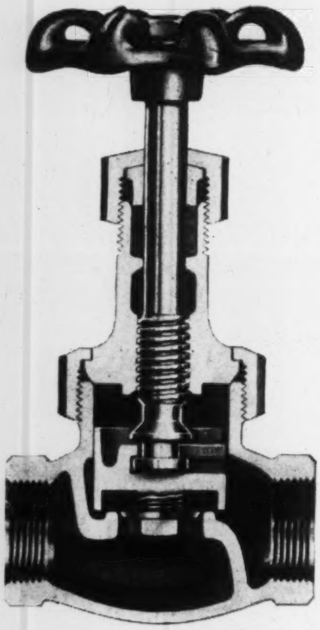
Walworth bronze valves...



Walworth No. 225P Globe Valve
500 Brinell Seat and Disc



Walworth
No. 29 Gate Valve



Walworth No. 95 Globe Valve
Re-New-Disc

built to give dependable trouble-free service on all recommended jobs

Walworth No. 95 Bronze Globe Valves (Angle Type: No. 96) are recommended for service where throttling is not required. They are rated at 150 psi working steam pressure, 500F; 300 psi cold water, oil or gas. The improved renewable disc and lock-on, slip-off disc holder — an original Walworth development—saves time and trouble. This valve can be repacked under pressure when fully opened. All parts are designed to give maximum service and strength.

Walworth No. 29 Bronze Gate Valves are rated at 200 psi working steam pressure, 550F; 400 psi cold water, oil and gas. These valves have rising stems and integral seats. Sizes 2-inch and smaller have union bonnets; sizes 2½ and 3-inch have bolted bonnets. Valves up to and including ¾-inch have solid wedge discs; 1-inch and larger have split wedge discs. These valves can be repacked under pressure when fully opened.

Walworth No. 225P Bronze Globe Valves (Angle Type: No. 227P) are rated at 350 psi working steam pressure, 550F; and 1000 psi non-shock service on cold water, oil and gas. The stainless steel, plug type seat and disc — heat treated to 500 Brinell — can be closed on sand, slag, scale and similar floatage, without injury to the seating surfaces. They are the longest wearing, TOUGHEST bronze valves you can buy.

For full information about Walworth Quality Bronze Valves, see your Walworth distributor, or write:

WALWORTH
valves and fittings
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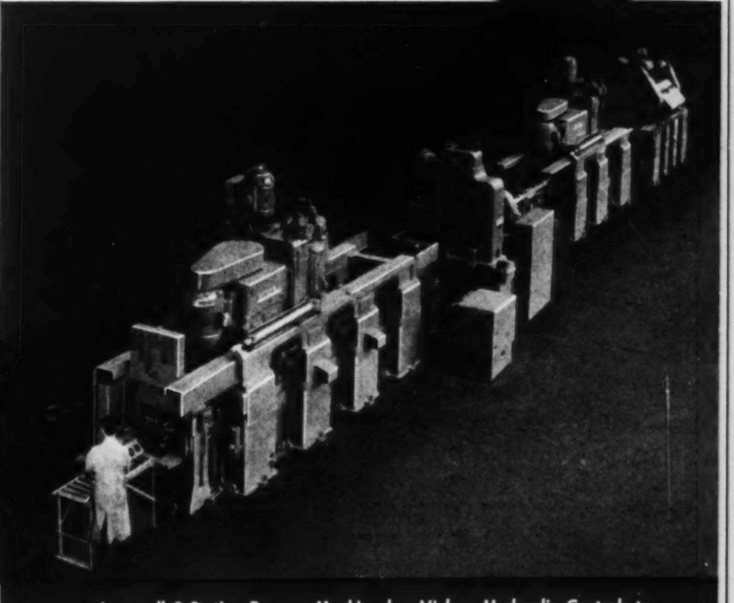
Another COST-CUTTING Application of VICKERS HYDRAULICS

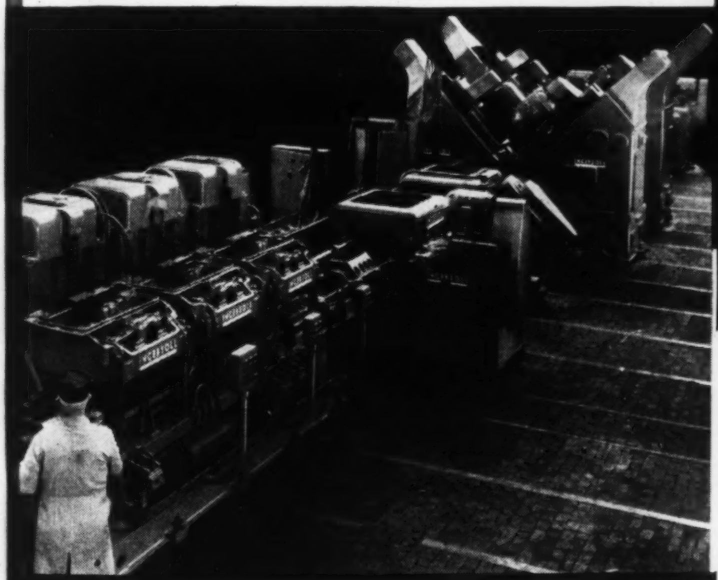
The two Ingersoll Process Machines illustrated here are being used for completely machining automobile cylinder blocks . . . they provide the extreme precision required and at the same time reduce the cost. It is significant that Ingersoll selected Vickers Hydraulic Controls for the many operations that can best be done with hydraulics.

Progression of the blocks through the machines is accomplished automatically, the time-saving transfer mechanisms being hydraulically actuated. Hydraulic circuits of the individual units provide for correct sequential positioning, clamping, traversing, feeding and returning. Interlocks assure accurate positioning, secure clamping and removal of interfering transfer members before cutting operations begin . . . also clearance of all cutters before transfer to next station can take place. Objectionable deflection is prevented by limiting the clamping pressure.

Get in touch with the nearest Vickers Application Engineering Office for information on how Vickers Hydraulics can improve your products.



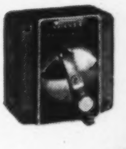
Ingersoll 9-Station Process Machine has Vickers Hydraulic Controls to help secure extreme precision in cylinder blocks at lowest cost.



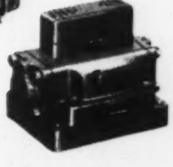
Ingersoll 11-Station Process Machine receives cylinder blocks from machine at right and similarly has Vickers Hydraulic Controls.

Representative VICKERS HYDRAULIC CONTROL UNITS USED ON INGERSOLL PROCESS MACHINES

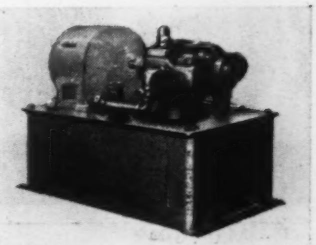
Pressure Controls, Bulletin 45-34a



Flow Control Valve, Bulletin 45-35



4-Way Valve, Pilot Operated, Solenoid Controlled, Bulletin 48-27



Power Unit, Bulletin 46-43a

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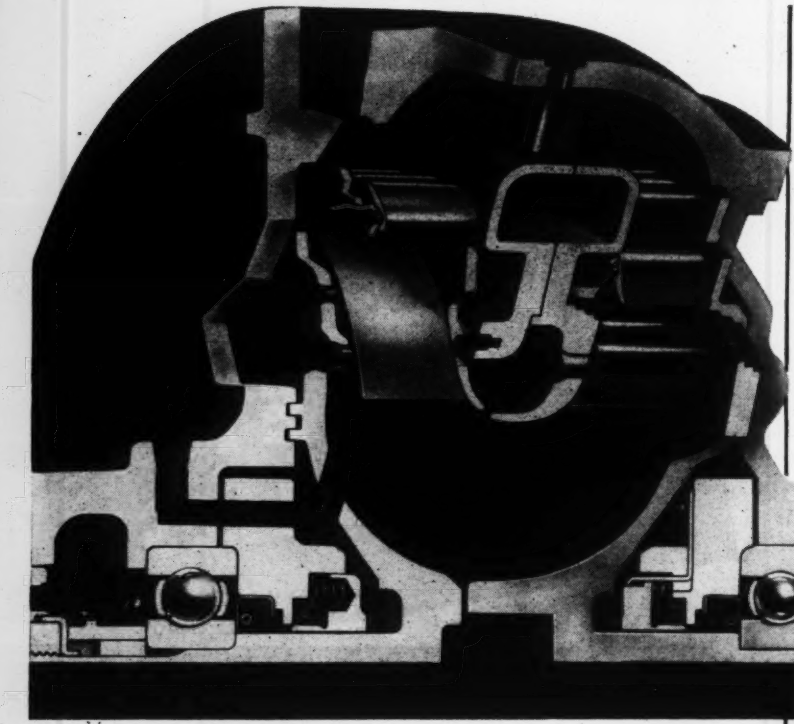
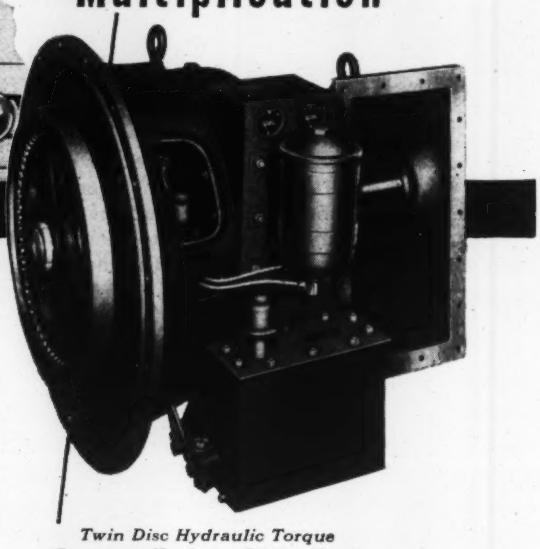


Sectioned view of Twin Disc Hydraulic Torque Converter

Greatest • Overall TORQUE Multiplication



Twin Disc Hydraulic Torque Converter (Lysholm-Smith Type)

When considering power transmission units for equipment with high torque demands, designers turn naturally to Twin Disc's Lysholm-Smith Hydraulic Torque Converter, because it offers the greatest overall torque multiplication of any unit made today.

The hydraulic circuit of Twin Disc's Converter consists of a centrifugal pump discharging through a *three-stage* turbine, with two reaction stages interposed between the turbine stages. Maximum torque is developed at output shaft stall and is approximately five times engine torque . . . maximum efficiency is attained at an output speed ratio of approximately .5.

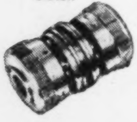
To apply a Twin Disc Torque Converter to any engine and machine assembly, it is necessary to select a converter with a proper pump size to absorb engine hp over its complete operating range. The drive ratios in the machine must be properly selected to obtain maximum converter performance throughout the complete range of output shaft operating speed.

The Twin Disc Hydraulic Division offers assistance in solving your power transmission problems. Torque Converter models are currently available with horsepower ratings from 50 to 600 hp. TWIN DISC CLUTCH COMPANY, Racine, Wisconsin (Hydraulic Division, Rockford, Illinois).

Power Take-off

Heavy Duty Clutch

Machine Tool Clutch



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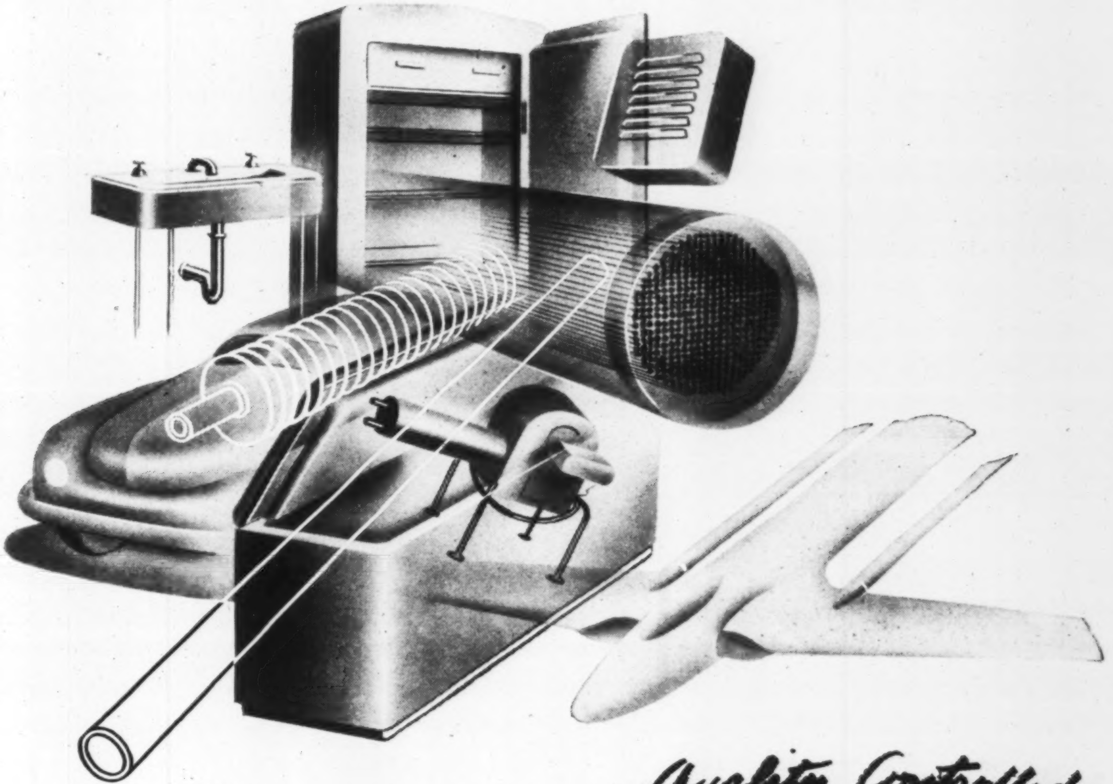

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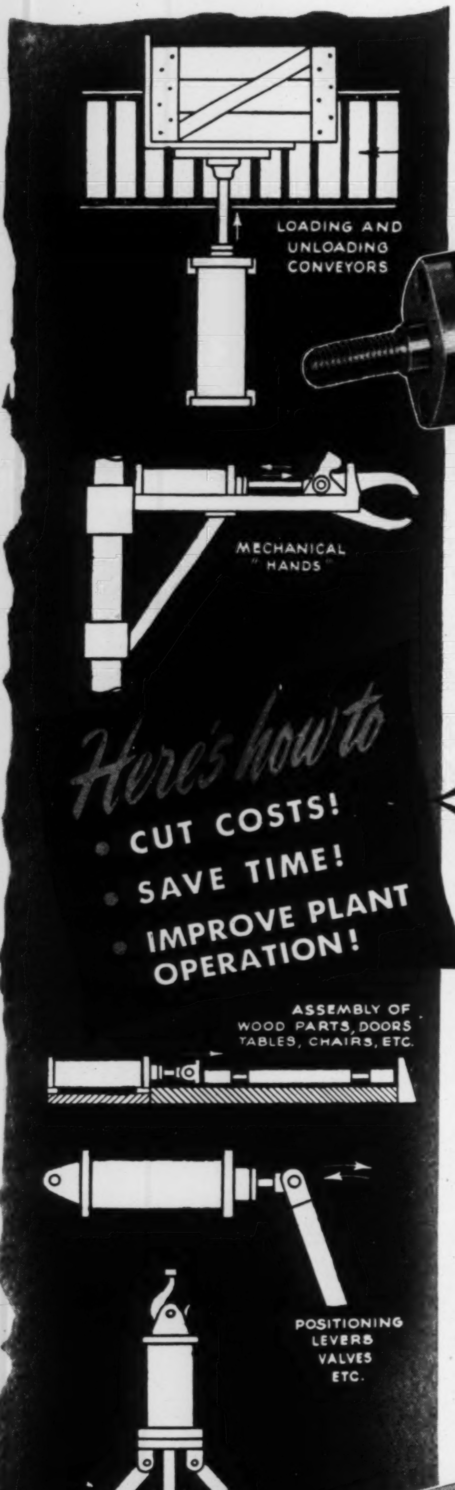
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SAVE TIME!
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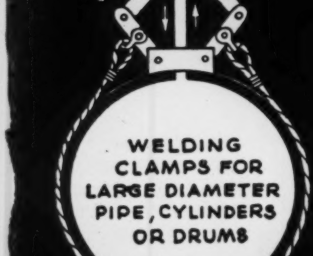
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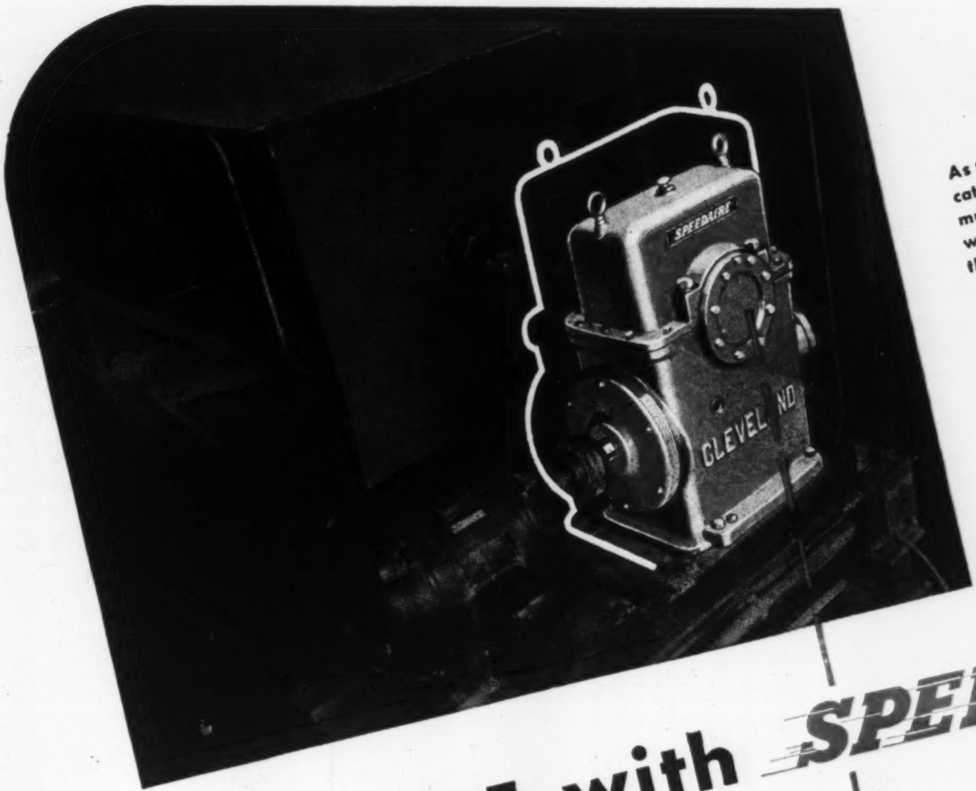

As the white outline indicates, a standard unit of much greater frame size would be required to do the work of Speedaire.

Cost cut $1315 with SPEEDAIRE

THIS installation demonstrates the remarkable capacity of Speedaire. It drives a large paste mixer filled with water, into which bags of dry paste are dumped one at a time. Mixing each batch takes 8 to 10 hours steady running.

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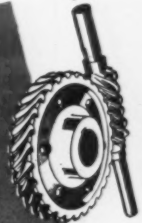
For full description, send for Catalog 300. The Cleveland Worm & Gear Co., 3264 East 80th Street, Cleveland 4, O.

Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers Limited.

CLEVELAND
Worm Gear
Speed Reducers



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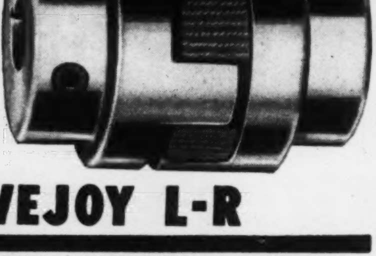
cushion
material



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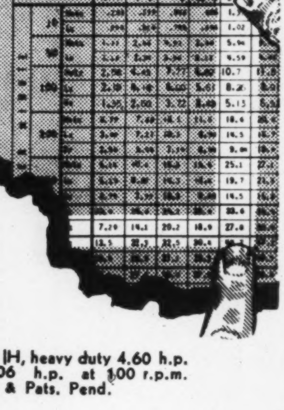
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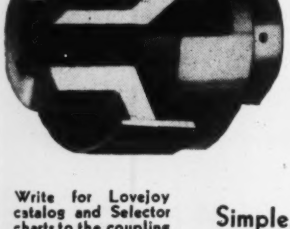
CAT. NO.



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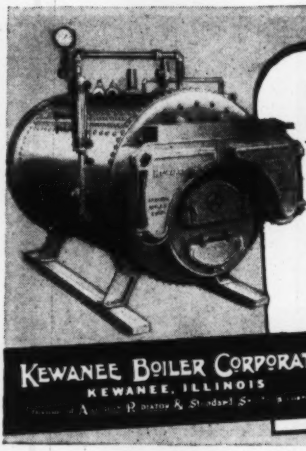

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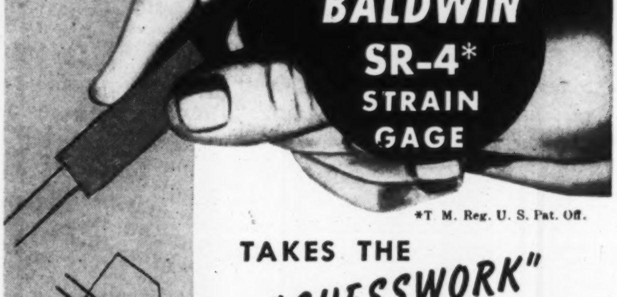

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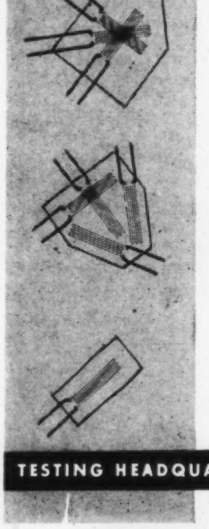

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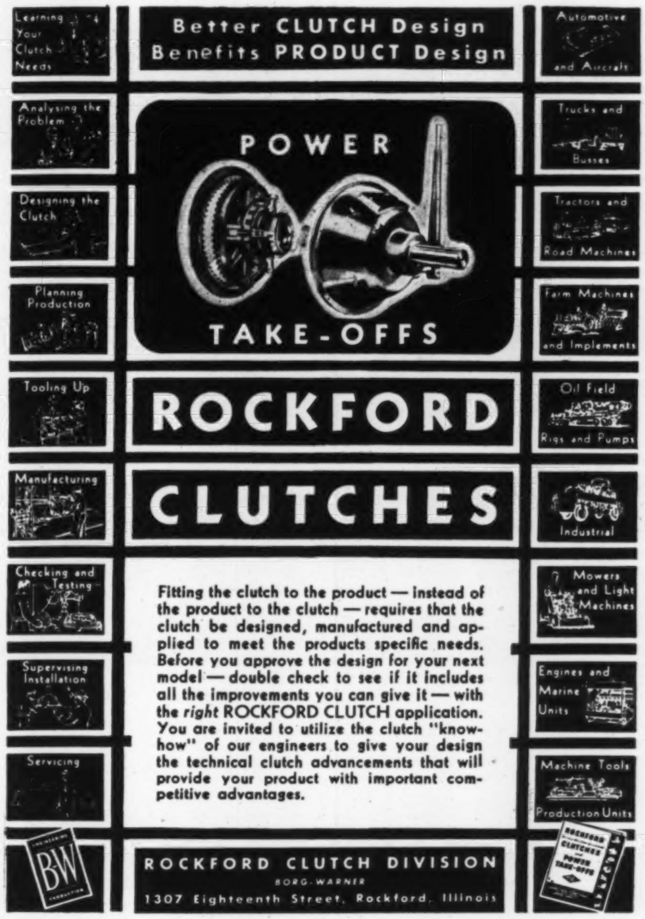
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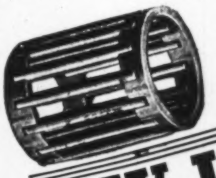

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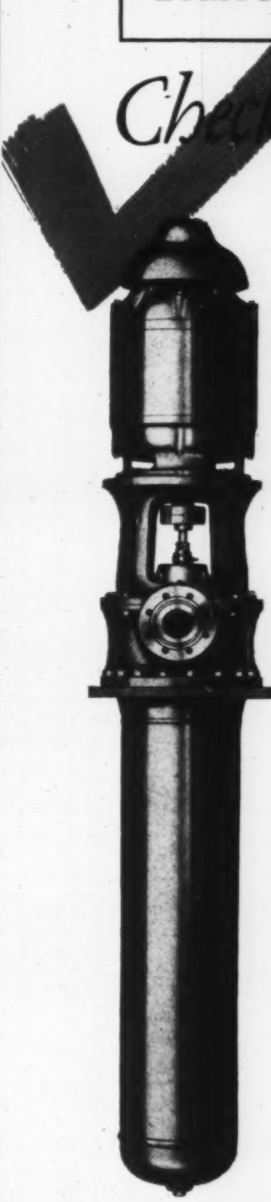

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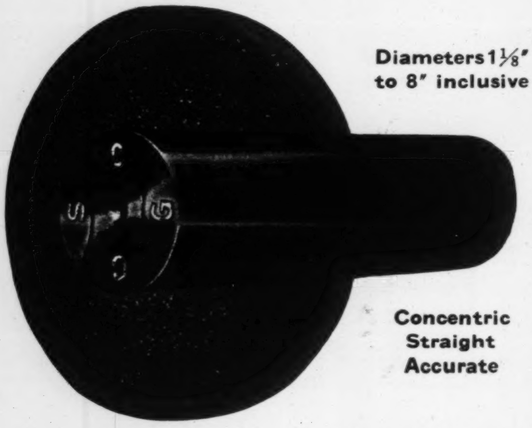

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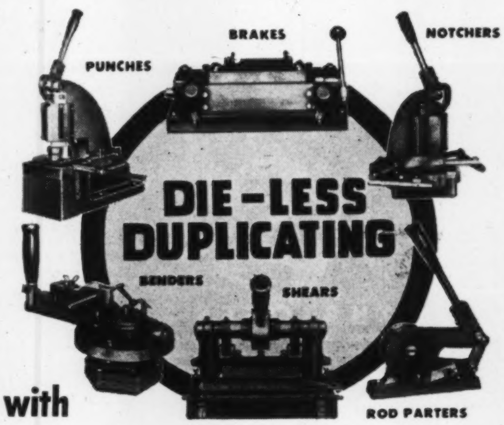

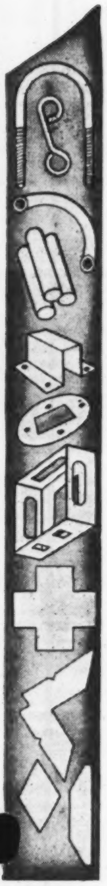

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Fig. 732
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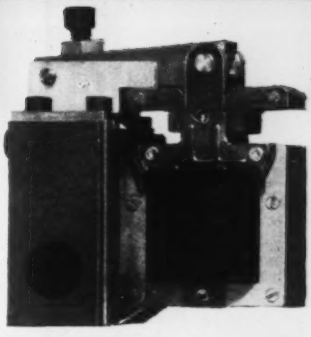

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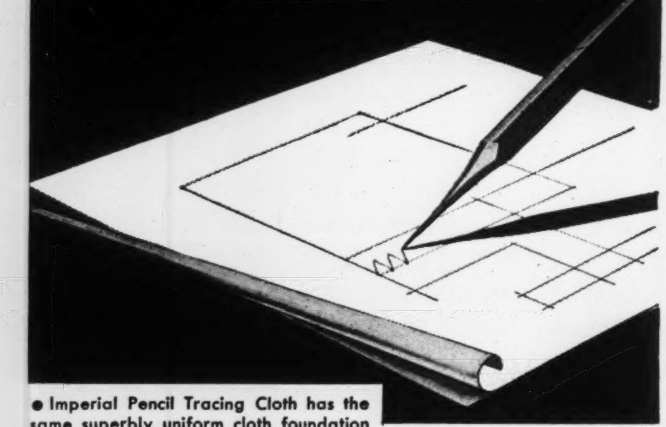

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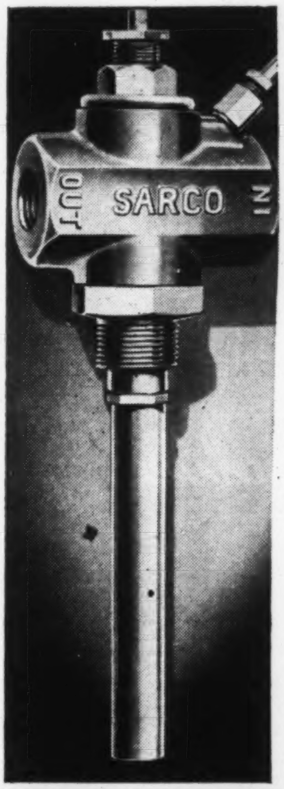

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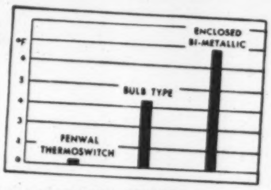

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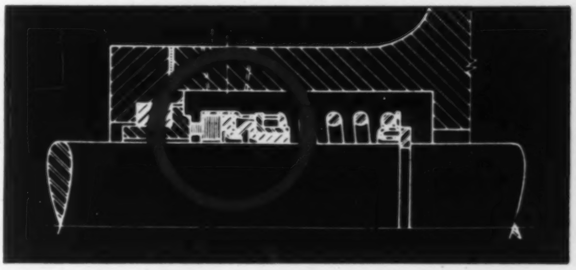
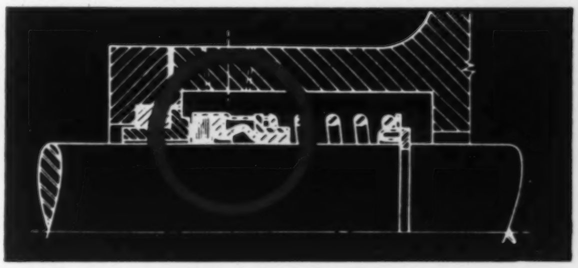


"John Crane" Type 1 Shaft Seal installed in stuffing box in position for use. Note Bellows in red circle.



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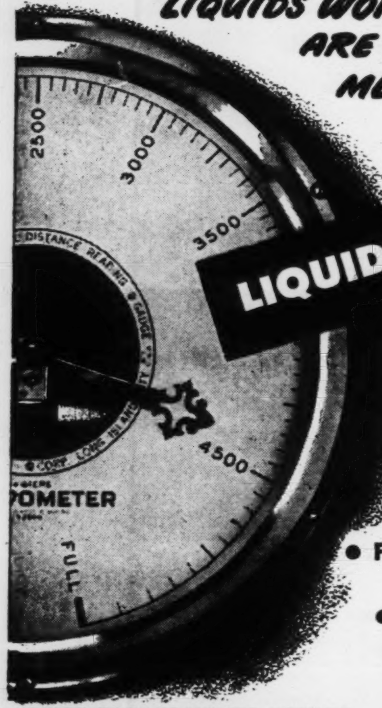

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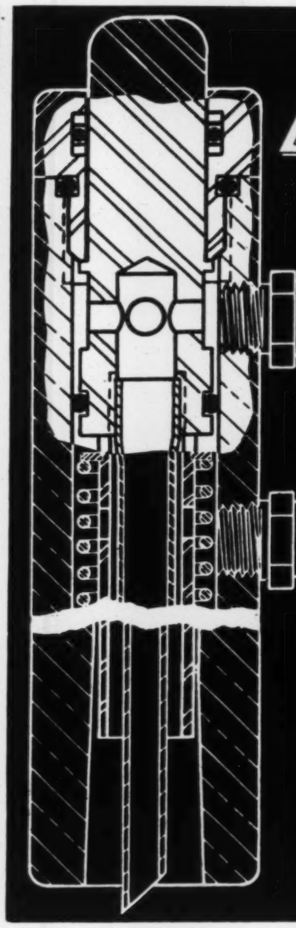

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It will pay you to watch the announcements on these pages for an opportunity that you may be looking for or one that may be of interest to you.

Continued on Page 112

Two Pages of Opportunities This Month . . . 111-112

Continued from page 111

POSITIONS OPEN

Continued from Page 111

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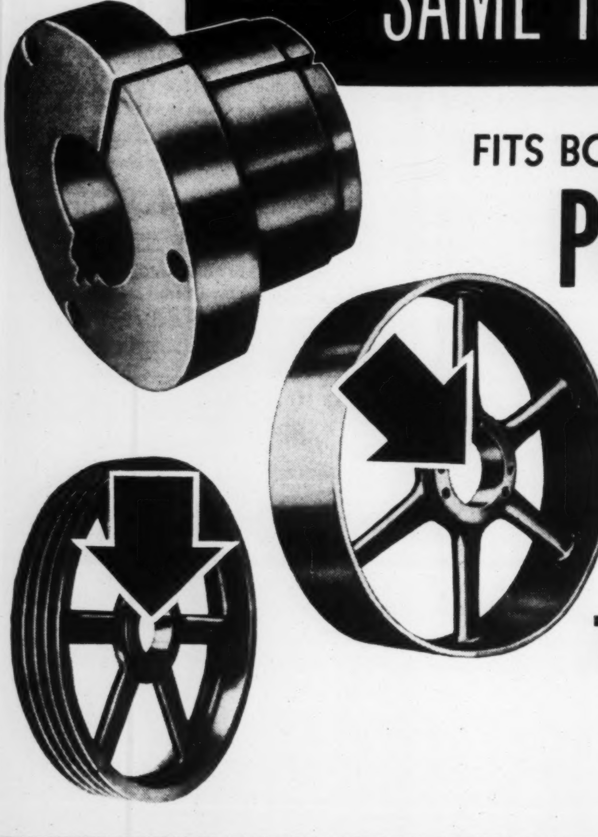

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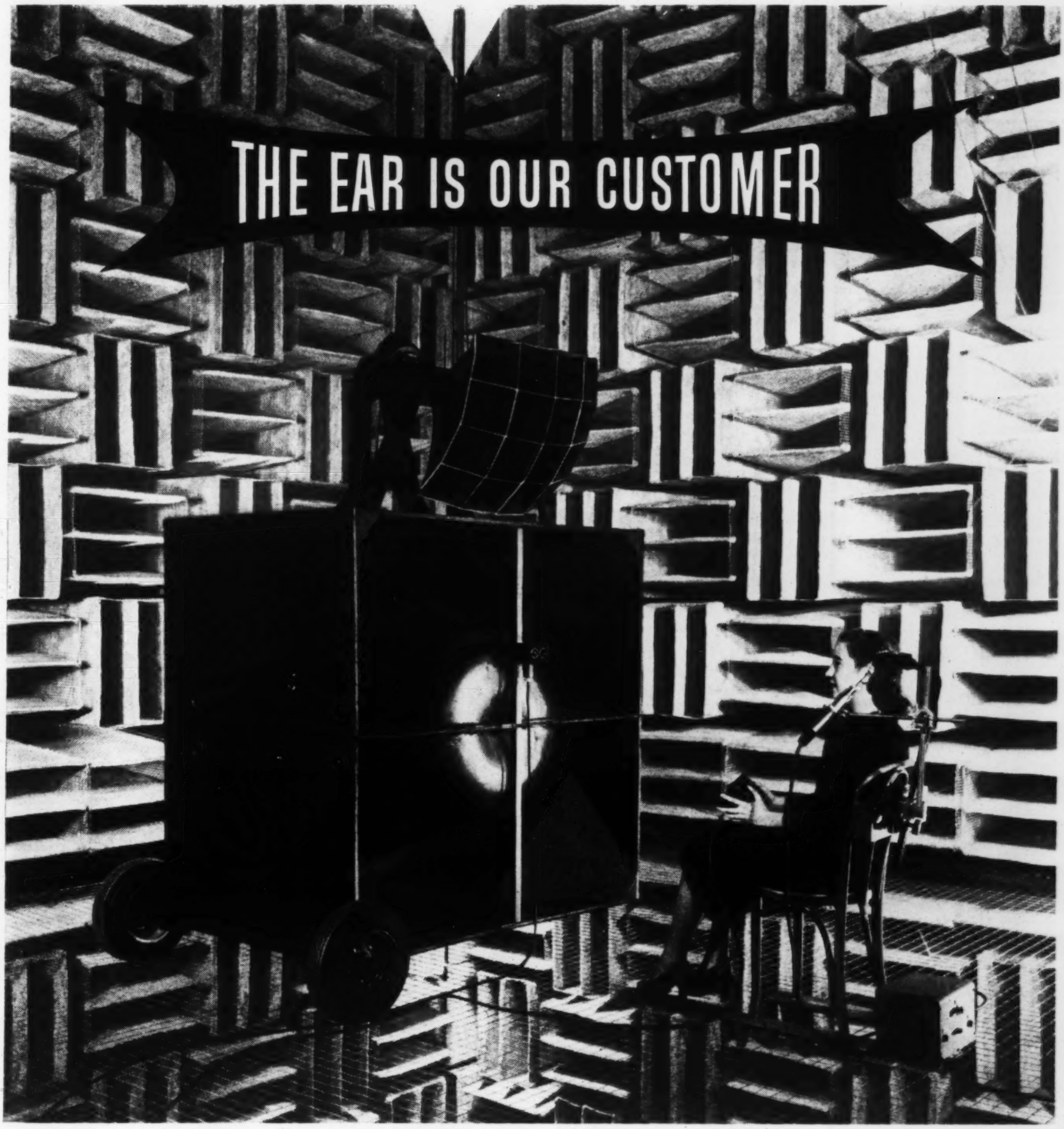
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Bell Telephone Laboratories scientists have developed special apparatus to help answer these questions, for the telephone system is designed to meet the ear's requirements for good listening.

In the test pictured above, the young lady sits before loudspeakers in a soundproofed room with a small hollow tube, reaching just inside the ear canal. Sounds differing slightly in frequency and intensity come from a loudspeaker. The subject seeks to tell one from another, recording her judgment electrically by pressing a switch.

Meanwhile, the same sound waves pass down the hollow tube to a condenser microphone, and a record is made of the exact sound intensities she identified. Results help reveal the sound levels you can hear clearly and without strain—the sounds your telephone must be designed to carry.

Scientists at Bell Telephone Laboratories make hundreds of tests in this manner. It's just one part of the work which goes on year after year at the Laboratories to help keep Bell System telephone service the finest on earth.

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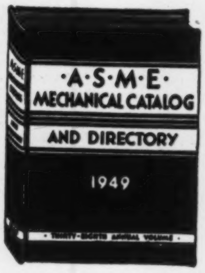

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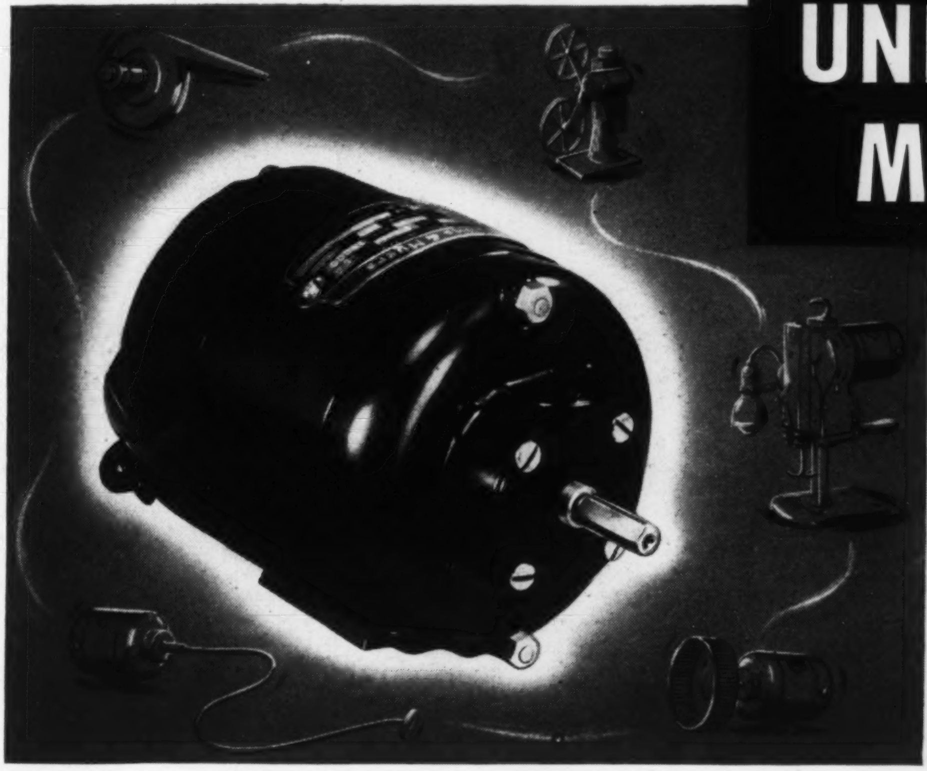

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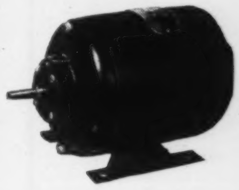

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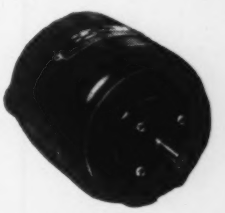

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